ROYAL BRITISH COLUMBIA MUSEUM

HANDBOOK No. 45

THE AMPHIBIANS OF BRITISH COLUMBIA

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Province of British Columbia
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PREFACE

This handbook is dedicated to the memory of G. Clifford Carl, director of the British Columbia Provincial Museum from 1940 to 1970 and author of many handbooks in the series including the original *Amphibians of British Columbia*.

We grew up with these handbooks; our worn copies are dog-eared and our pencilled comments now litter their pages. Since Dr. Carl wrote his amphibian handbook, much more information about British Columbia's frogs, toads and salamanders has been learned, although there is still a great deal to learn. The present handbook is an entirely rewritten and newly illustrated successor to Carl's 1943 handbook.

Many people helped in the production of this handbook. We wish to thank Keith Taylor and Brigitta M. Van Der Raay for their superb illustrations. James P. Bogart, Francis R. Cook, Fred W. Scheuller, Patrick T. Gregory and David L. Servage reviewed the manuscript.

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CONTENTS

	Page
Preface	iii
Amphibians	1
Fossil History and Distribution	1
The Skin of Amphibians	5
Amphibians and Temperature	7
Metamorphosis	8
Ecology and Economics	10
Amphibians in Folklore	12
Care of Captives	13
Where to Find Amphibians	15
The Study of Amphibians	17
Scientific and Common Names	18
About the Keys and Descriptions	19
Checklist of British Columbia Amphibians	21
Salamanders	22
Breeding in Salamanders	23
Regeneration in Salamanders	25
Artificial Key to Living Adult Salamanders of British Columbia	27
Rough-skinned Newt	28
Long-toed Salamander	31
Northwestern Salamander	34
Tiger Salamander	37
Pacific Giant Salamander	40
Western Red-backed Salamander	43
Ensatina	46
Clouded Salamander	48
Frogs and Toads	51
Voice and Social Behaviour in Frogs	52
Breeding in Frogs	55
Artificial Key to Living Adult Frogs and Toads of British Columbia	59
Tailed Frog	60

Great Basin Spadefoot Toad 64
Western Toad 67
Pacific Treefrog 71
Northern Chorus Frog 74
Reg-legged Frog 77
Spotted Frog 79
Cascades Frog 82
Northern Leopard Frog 84
Wood Frog 87
Bullfrog 90
Green Frog 93

Glossary 97

Useful references 98

General Works 98
Field Guides and Handbooks 99
Scientific Journals 99

PROVINCE OF
BRITISH COLUMBIA
SCALE
MILES
KILOMETRES
YUKON
ALASKA
ATLIN
CASSIAR DISTRICT
Liard R.
N.W.T.
FORT NELSON
Stikine R.
ROCKY MOUNTAINS
Williston Lake
Peace R.
ALBERTA
DAWSON CREEK
PRINCE RUPERT
Skeena R.
Bulkley R.
Babine L.
Nechako R.
PRINCE GEORGE
QUEEN CHARLOTTE IS.
INTERIOR PLATEAU
CARIBOO MTS.
Fraser R.
North Thompson R.
COLUMBIA MTS.
Columbia R.
Monashee Mts.
Selkirk Mts.
Kootenay R.
KAMLOOPS
VANCOUVER ISLAND
VANCOUVER
VICTORIA
Georgia Str.
CRANBROOK
CASCADE MTS.
IDAHO
MONTANA
WASHINGTON
PACIFIC OCEAN
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AMPHIBIANS

Amphibians are a class of "cold-blooded" vertebrate animals that have glandular skins lacking any epidermal coverings such as fur, scales or feathers. Living amphibians are classified in three orders: the Anura (frogs and toads), the Caudata (salamanders and newts) and the Apoda (Caecilians). The typical frog is familiar to everyone. Everyone knows that a frog is stout-bodied and large-eyed, has long hind legs for jumping and has no tail. It sings in the springtime. A frog lays eggs in the water which hatch into fish-like, wriggly tadpoles and eventually the tadpoles transform (metamorphose) into little frogs. But an enormous amount of variety exists among the some 2,770 species of frogs and toads in the world. They don't all have large eyes and they don't all lay eggs in water.

Salamanders and newts are generally more secretive than are frogs. They are long bodied and have tails. Superficially, salamanders resemble lizards, which are reptiles. But unlike lizards, salamanders do not have scales or claws and lizards do not have aquatic larvae. There are about 350 species of newts and salamanders known.

The third order of amphibians is not found in British Columbia. Caecilians are circum-tropical burrowing animals that have neither legs nor tails. Little is known about most of the 70 or so species living today. They are elongate and worm-like with reduced, sometimes non-functional eyes buried under the skin of the head. A unique and peculiar sensory tentacle grows on either side of the head.

Nineteen species of amphibians are known to occur in British Columbia. These include 11 kinds of frogs or toads and 8 kinds of salamanders.

Fossil History and Distribution

Amphibians are ancient. The fossil record of amphibians goes back some 350 million years to the Devonian period of the geological time scale. At that time, amphibians were the only vertebrate animals to live on land. The first amphibians were very fish-like. They had rayed tail-fins, as do fishes, but their legs had fully developed toes and they could breathe air. The name "amphibian", which means "double life" in reference to living both in water and on land, was truly appropriate for these creatures that were half fish and half land animal.

In the later Carboniferous period, about 300 million years ago, amphibians diverged widely. Some grew to massive sizes. A large and diverse group of these amphibians, termed Labyrinthodonts, retained the heavy, bony skeletons of their fish-like ancestors. The early types of amphibians declined in numbers after the Carboniferous period and all finally became extinct during the subsequent Mesozoic era, known as the age of Dinosaurs.

The possible links between the ancient amphibians and the modern amphibians are difficult to ascertain. The meagre fossil evidence available provides only a glimpse of the early history of the modern frogs, salamanders and caecilians. The fossils indicate, though, that these groups do have an ancient history. Their antecedents may have existed during the Carboniferous period alongside the Labyrinthodonts. The oldest known fossil frogs are from the Triassic period in the Mesozoic era, about 200 million years ago. Frogs that were similar to some primitive frogs living today are known from the later Jurassic and Cretaceous periods. Fossil frogs are known from about 180 million years ago, the time of the Jurassic period, that show many similarities to our own Tailed Frog, *Ascaphus*. The earliest salamander fossils also date back to the Triassic period. Some present-day genera of newts have been found as fossils in rocks dating as far back as the Eocene epoch, 50 million years ago.

Tailed Frog

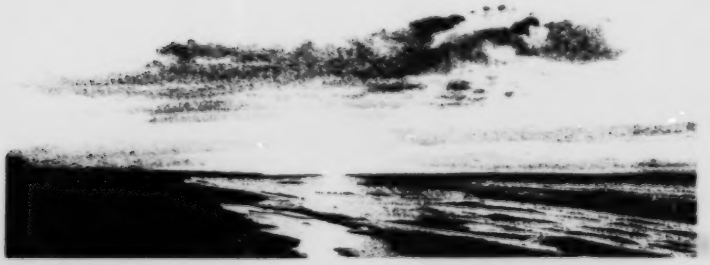
In all the present-day amphibians, the skeleton is highly modified. Many of the bones are reduced or fused or left cartilaginous. These small, soft and delicate skeletons do not fossilize easily and are frequently overlooked if they do. Fossils of modern types of amphibians are, therefore, understandably rare and we will probably never have a complete record of their history.

The worldwide distribution of living amphibians owes much to the consequences of continental drift. Most of the present major families of amphibians arose during the Mesozoic era, about 60 to 120 million years ago. At the beginning of the Mesozoic era the continents as we know them were coalesced into a single, huge super-continent known as Pangaea. During the Mesozoic period, this great land mass split apart. At first Pangaea fractured into northern and southern continents, which have been called Laurasia and Gondwanaland respectively. Later, in the Cretaceous period, these split into the several continents of today. Each of these land masses carried with it its own contingent of amphibians, as well as other living things. Consequently, it seems that the caecilians, which are distributed across the globe but are restricted to the tropics, were once inhabitants of Gondwanaland, the southern continent which split apart into South America, Africa and India. The salamanders appear to have arisen on Laurasia as they are now distributed across the northern continents of Asia, Europe and North America. Frogs and toads are more widely distributed than the other two living orders of amphibians and probably had spread all over Pangaea before the great continental breakup. Today there are distinctly northern families of frogs such as the spadefoot toads and their relatives in Europe and there are southern families of frogs such as the Leptodactylids of South America, Africa and Australia. Some frog families like the Bufonid toads, Ranid frogs and Hylid treefrogs, appear to have had a southern origin but have invaded the northern continents.

The precise distributions of the species of amphibians now found in British Columbia are related to events of the more recent past than to continental drift. Amphibians cannot abide regions of extensive cold or drought nor can they withstand the salinity of sea water. The amphibians of British Columbia are generally at, or near, the northern limits of their ranges and all of them, except those that were introduced by people, probably invaded the province well after the close of the most recent Ice Age eight to ten thousand years ago. Following the retreating ice and

glaciers, the amphibians entered the province through the valleys between the mountain chains and along the coast. Some species, such as the Rough-skinned Newt, the Red-legged Frog and the Northwestern Salamander, moved up the Pacific coast and did not cross over the coast mountains into the interior. Other, more arid adapted species, like the Tiger Salamander and the Great Basin Spadefoot Toad, entered the province through the interior valleys. The Wood Frog, Northern Leopard Frog and Northern Chorus Frog have entered the province from east of the Rocky Mountains. The spread of some widely distributed species such as the Western Toad and the Spotted Frog seems to have been less affected by British Columbia's mountainous terrain but these species are stopped by the colder climate of the far north. The varieties of the Long-toed Salamander show evidence that this species may have entered the province separately through coastal, interior and eastern routes from the south.

The distribution of amphibians on the offshore islands is interesting. Salt water is lethal to amphibians. Hecate Strait, Johnstone Strait, Georgia Strait and the Strait of Juan de Fuca are formidable barriers to the easy spread of amphibians from the mainland. The Clouded Salamander may have found refuge on Vancouver Island during the Ice Age but has been unable to significantly reinvade the nearby mainland. Only the Western Toad has apparently managed to cross Hecate Strait without the help of man to colonize the Queen Charlotte Islands.



The Skin of Amphibians

Without an external covering of scales, feathers, or hair, the skin of a frog or a salamander is exposed directly to the environment. But, perhaps because of this, the skins of amphibians are developed into complex, highly vascularized, living structures. With a skin that is permeable to water, an amphibian's ability to invade dry environments is restricted. But an amphibian can both breathe and absorb water through such a skin, which can be advantageous. Amphibians do not drink through their mouths but can absorb water through their skins.

In sea water, which is saltier than the amphibian's bodily fluids, osmosis is reversed and an amphibian will lose water through its skin. This is why immersion in salt water will usually kill an amphibian.

Gas exchange in breathing (the uptake of oxygen and the release of carbon dioxide) requires a moist, vascular membrane for the gases to diffuse across. In most land-dwelling vertebrates this occurs in the lungs. The pumping throat of an amphibian serves to force air in and out of the lungs. Amphibians have no internal diaphragm to do the job. Fishes use gills to breathe in water. Amphibians can use their skins and the lining of their mouths to breathe as well. This ability enables amphibians to hibernate under water in winter. They can receive enough oxygen for respiration from the cold water through their skins without having to surface for air. The lungless salamanders, family Plethodontidae, have dispensed with lungs altogether and rely entirely on cutaneous respiration through the skin and buccal respiration through the lining of the mouth.

Amphibians are faced with the problem of keeping their living, permeable skins moist so that they will not dessicate and die. Accordingly, amphibians are rarely found far from moisture. Those that live in dry regions, like the Great Basin Spadefoot Toad, escape from drought by burrowing into the ground to where the soil is moist. But amphibians also have a variety of skin glands that help keep the skin moist or help to protect them from enemies. There are two major types of skin glands in amphibians; mucous glands and granular, or poison glands. Mucous glands are small glands distributed all over the body. The pores where these glands open onto the skin are microscopic. The glands secrete fluid mucus that helps lubricate the skin and keep it from drying. These are the secretions that make frogs and salamanders so slippery.

Great Basin Spadefoot Toad

The poison glands of the skin are larger structures than the mucus glands. They are located in discrete places on the upper surface of the body, tail and head. The warts and parotoid glands of toads are modified and specialized poison glands. The ridge on the tail of the Ensatina and the granular bumps on the skin of the Rough-skinned Newt are also poison glands. Amphibian poison glands usually produce a bitter, white, sticky fluid that is irritating to mucous membranes lining the nose and mouth. Some frogs and salamanders can definitely make you sneeze. Amphibian poisons range from the bitter but essentially harmless secretions of the Western Toad to the highly toxic poisons of some newts or tropical frogs such as the Poison-dart frogs, family Dendrobatidae, of Central and South America. The secretions themselves contain many amines and other nitrogen containing compounds and may originally have been used as a means of excreting nitrogenous wastes. Despite their toxicity, the noxious skin secretions of amphibians are all purely for defense. No amphibian has a poisonous bite or can inflict a poisoned wound. The skin poisons are released only when the animal is in extreme duress and their main purpose is to render the toad, newt or frog somewhat less than a tasty meal.

Amphibians periodically shed the outermost layer of the skin as they age and die. The whole outer layer is shed at one time, either in one piece or in large patches. Frogs and toads begin shedding by working the old skin layer off of their backs with their legs. They use their mouths and arms to help pull it off of the rest of the body and they generally swallow it as they go. The new skin now exposed is clean and bright.

Amphibians and Temperature

Amphibians are commonly known as "cold-blooded" animals. This term "cold-blooded" is a misnomer as the difference between a "cold-blooded" animal and a "warm-blooded" animal is not due simply to the temperature of the blood. The important points are: 1) whether or not the body temperature remains constant (homeothermy) or can be variable (poikilothermy) and 2) whether heat to warm the body is generated inside metabolically (endothermy) or must be absorbed from without (ectothermy). In most, but not all cases, ectothermy and poikilothermy go together, as in most amphibians. This is what is usually meant by the general term "cold-blooded".

In practical terms, an amphibian does not produce enough metabolic heat to enable it to warm its own body, as birds and mammals do. Its body temperature is dependant upon the temperature of its surroundings. This is not without its advantages. An amphibian does not have to eat as much or as often as does an endothermic bird or mammal because it does not have to burn up so much of its food as fuel to keep its body warm. More food can be directed towards growth and reproduction. An amphibian can also afford to be much smaller than a bird or mammal because it does not have to worry so much about heat loss. However, an amphibian's activity is restricted to conditions with favourable temperatures, which means it must avoid extreme heat or cold. Consequently, amphibians living in regions with cold winters or hot summers must lie dormant during those times, either hibernating or aestivating, until suitable weather.

Western Toad

The metabolic activity of a poikilotherm like a frog varies with temperature. A frog is much more active when it is warm than when it is cold. When the frog is very cold, just above freezing for instance, its metabolic activities can slow to a minimum. Oxygen demand can be so low that enough of it can be obtained entirely from the water through the skin. In this way an amphibian that in summer will drown without air to breathe can survive dormant underwater during the winter at near freezing temperatures. When the water temperature rises in the spring, the metabolic activity of the hibernating frog or salamander will rise too and it will again become active. During some mild winters on the south coast of British Columbia, the temperature may never get very low for very long and some species of amphibians may remain active all winter.

Metamorphosis

One of the characteristics of amphibians is their two-part life history. Most species of amphibians pass through a free-living larval stage during

Tadpole of the Wood Frog

their early lives before transforming into adult form. This kind of life history is not uncommon through the various branches of the animal kingdom but among the terrestrial vertebrates it is present only in the amphibians. Usually a larva looks and behaves quite differently from an adult. It may live in a different habitat or eat different sorts of food. The tadpole of a frog is a larva and so is the caterpillar of a butterfly or the grub of a beetle. The process of transformation from the larval to the adult form is called metamorphosis.

In amphibians, metamorphosis is mediated by hormones, especially thyroxine which is produced in the thyroid gland located near the throat. Tadpoles or salamander larvae which have been deprived of their thyroids by surgery will not metamorphose unless they are given thyroxine. Iodine is a vital ingredient in thyroxine. If absolutely no iodine is present in the water, the larval amphibian will be unable to make any thyroxine and so will be unable to transform. However, only trace amounts of iodine are usually needed. The transformation of a tadpole to a frog is a spectacular change. Not only are there external changes taking place, such as the loss of the tail, the growth of legs, the bulging of the eyes and the changes in the colour and texture of the skin, but there are also internal changes. The gills are resorbed as lungs grow. The intestine shortens and differentiates to accommodate a carnivorous diet. Blood vessels alter their courses. All of these changes that occur in the metamorphosis are governed by the various tissues' reaction to thyroxine. The larvae of salamanders do not go through quite as marked a metamorphosis as tadpoles undergo but many changes in appearance, behaviour and physiology occur as they transform into terrestrial adults.

The release of thyroxine from the thyroid gland is controlled, in turn, by the release of a thyroid stimulating hormone, TSH for short, produced by the pituitary gland under the brain. But it appears that the release of this hormone is controlled by another secretion that is produced by the hypothalamus of the lower brain whose release is stimulated by thyroxine! Thus, in a round-about way, release of thyroxine stimulates the release of more thyroxine, a positive feedback driving metamorphosis to completion.

Larva of the Tiger Salamander

Not all amphibians undergo a metamorphosis during their lives. Some salamander species remain as essentially permanent larvae and never transform. It is thought that in some of these species, the hypothalamus may not produce enough of its secretion. These species, like the Axolotl or neotenic Northwestern Salamanders, can be made to transform if they are administered thyroxine. Other species of neotenic salamanders may simply be insensitive to the actions of thyroxine. Members of the families Proteidae and Sirenidae will not transform even if given thyroxine.

Some other salamanders and many frogs bypass the free-living larval stage by going through direct development to the adult form while within the egg. The young of these species hatch or are born as tiny replicas of their parents.

Ecology and Economics

All species of amphibians are carnivorous for most or all of their lives. All salamanders and their larvae are strictly carnivorous. The tadpoles of frogs and toads are mainly herbivorous and consume aquatic plants but when they grow and transform into adults they eat animal prey. Amphibians thus play an important role in the balance of nature as effective small predators. They generally consume small animals such as insects, worms or other invertebrates. Many species of amphibians can be quite abundant and they form important links in the food chain. Frogs and toads consume large numbers of insects and may thus destroy many agricultural pests. In turn, amphibians are eaten by other predators such as snakes, raccoons, hawks or fish. Rarely can an amphibian eat an animal large enough to be considered economically important. No amphibian is directly harmful or dangerous to man.

Many amphibians, especially large frogs and salamanders, are used in biological research and in teaching. They make ideal subjects for many research projects because they can be readily collected in many areas and they are fairly easy to maintain in a laboratory. Medical research, embryology, genetics, physiology and other scientific fields rely heavily on amphibians. Some species, especially Northern Leopard Frogs, are heavily collected for research and teaching purposes and may in fact be over-exploited in some parts of North America.

Large frogs, like Bullfrogs, are sometimes used in restaurants, although many commercial frogs' legs are now imported from Europe or Japan. Most of the introductions of Bullfrogs in western North America, which is outside the Bullfrog's native range, are due to attempts to grow Bullfrogs commercially. These, largely unsuccessful and now usually

Bullfrog

defunct, "frog farms" were established when the eating of frogs' legs was more in vogue. Now the feral, former inmates of such "farms", have established healthy, growing populations in many isolated localities. Bullfrogs are still exploited for food within their native range. Contrary to their growth in numbers in the west, native Bullfrog populations appear to be declining in many areas.

Countless numbers of children have been introduced to the wonders of natural history and the living world through a pet frog or a metamorphosing tadpole in a classroom. Amphibians may not be as playful as a dog or cat or as spectacular as many tropical birds or reptiles but each year large numbers of exotic amphibians are imported for the pet trade. The native amphibians are just as engaging and certainly easier to care for than many of these exotics.

Amphibians in Folklore

In many European cultures, amphibians have often been associated with spirits of evil; the "eye of newt" as an ingredient to witches' brew comes to mind. Through most of the rest of the world, though, amphibians, and frogs in particular, are regarded as portents of spring and good tidings. All through the world the singing of frogs heralds the good weather of spring. In Panama and Costa Rica, the Golden frog, a colour form of *Atelopus varius*, was formerly a religious symbol and is still revered as a popular artistic motif. In Mexico, a legend has it that the frogs are responsible for the coming of the life-giving rains. The legend relates how the frogs tricked the gods of the winds into bringing the rain. The "toad-stone" of European legend, which supposedly resides in the head of a toad, was imbued with magical properties. A number of subterfuges could be employed to trick the toad into relinquishing its toad-stone. Shakespeare alludes to the toad-stone in "As You Like It";

> ". . . the toad, ugly and venomous
> Wears yet a precious jewel in his head."

The "jewel" of Shakespeare's lines may ultimately refer, though. to the gleaming gem-like eyes of the toad, the probable origin of the toad-stone legend. In China, a three-legged toad is a mythical embodiment of both greed and thriftiness.

A border of frogs (or toads) on a blanket: From a drawing by Charles Edensaw, Masset, Q.C.I.

In British Columbian native cultures, frogs or, more likely, toads are frequent motifs in artworks and in totems. They are especially prominent among the Haida of the Queen Charlotte Islands and the Tsimshian of the

Skeena River region. One Haida myth holds the frogs to be the source of wisdom and knowledge. Another west-coast legend features two frogs guarding the entrance to the realm of the Thunderbird, ready to croak a warning in case of any intruders. These Haida myths may be in reference to toads, *Bufo boreas*, and not frogs such as *Rana pretiosa*, because toads are the only amphibians to be found natively on the Haida's home Queen Charlotte Islands.

But it is nevertheless possible that the Haida were impressed with the sound of the Pacific Treefrog on the mainland.

A "man in the moon" sort of story originates from the Salish Indians. In alternate versions, the story features either one frog or three frogs who are courted either by Beaver or by Beaver and his brothers. In the simplest version, Beaver proposes marriage to Frog but Frog refuses. The tears of the rejected Beaver are so copious that he floods the river, sweeping away Frog and her house to the land of the Moon. Kindly, Moon invites Frog to sit by his fire. But Frog wants to get closer to the fire and so Moon finally lets her sit on his forehead. At night, so the story ends, when the moon is up and full, Frog can still be seen sitting on the brow of the moon.

Care of Captives

Amphibians are not difficult to maintain in captivity. They do not require constant attention and indeed they may fare better if simply watched and left to themselves with a minimum of handling. They do need proper surroundings and food. The first thing to do, before taking an amphibian home, is to learn about its habits, food preferences and habitat requirements. Then an environment can be fashioned and care can be given that will satisfy its needs.

All amphibians must have water. An amphibian cannot be left in a completely dry cage without risk of it drying up and dying. Amphibians do not drink but instead absorb water through their skins. They also lose water through their skins by evaporation. Standing water or moisture is essential. Different species require different amounts of water. A Bullfrog can be quite happy in an aquarium half full of water but for most terrestrial species, like toads or newts, a shallow dish of water is sufficient. The water dish must not be so small or steep sided that the animal cannot sit entirely in the water. Of course, aquatic salamanders and

tadpoles need deeper water. For these animals, if tap water is used it must be left to sit for at least a day before use to allow any chlorine to dissipate. Tailed Frogs and many aquatic salamanders need aerated water.

An aquarium can make a fine home for an amphibian. But an all glass, water-tight aquarium can be expensive and is really only necessary for highly aquatic species. A good cage for most species can be fashioned out of a wooden box, perhaps fitted with a glass front and a screen top. Use fibre-glass screening rather than wire mesh on which the animals might injure themselves. Very small specimens can be housed in large jars with screen tops.

Pacific Treefrog

Sandy soil makes a good substratum for a terrarium. Toads need somewhere to dig. Salamanders need something to hide under. Treefrogs may be provided with branches to climb on. There are limits as to how natural a terrarium can be landscaped, though. A toad can uproot all the plants in its enclosure unless thay are somehow protected from its burrowing. Keep the terrarium simple and do not crowd amphibians. Amphibians usually do best when alone. They do not get lonely. Amphibians should always be kept away from sources of heat and from direct sunlight. Normal room temperatures are usually best.

Frogs and toads eat living, moving prey. If something does not move it just is not recognized as food. Salamanders are also enticed by movement but they can also hunt by smell. Amphibians, therefore, must be provided with live food, such as worms, slugs or insects gathered in the garden.

Mealworms can be bought and cultured in bran but they are low in some essential vitamins. A varied diet is best for a captive. Salamander larvae need live, aquatic prey. Brine shrimp or small worms will do. Tadpoles can be fed a steady diet of boiled lettuce.

Tadpoles are easy to keep until they transform into frogs or toads. The change can be rapid and, once it is complete, the little froglet is liable to drown unless land is provided for it to crawl out on. This must be provided as soon as the front legs appear. Newly transformed froglets are extremely difficult to maintain and should be released where they were first captured.

With a little care and effort, a frog, toad or salamander can survive well in captivity. Much valuable behavioral information can be gained from observing a captive. However, if proper care cannot be ensured, let the animal go. Release it right where it was caught and do so before it is too weak to survive on its own. Do not release any animal away from its natural habitat. Its chances of survival in a foreign environment are small.

Where to Find Amphibians

The easiest way to find frogs and toads is to search for them in the spring when they are breeding. All of our frogs and toads, except the Tailed Frog, breed in ponds, small lakes or sloughs. Good potential breeding sites can be located by scouting around during the day and then can be visited later in the evening when the frogs are active. Most species of frogs and toads can be located by the calls they make. Calling adult frogs can be located easily in the dark with the aid of a flashlight or headlamp. They are sometimes so intent upon calling and mating that they

can be approached with ease. The breeding sites, of course, will yield tadpoles later in the year. Tadpoles can be caught with a dip net.

Throughout the rest of the year, frogs and toads may roam farther afield. Ranid frogs, (especially Spotted Frogs, Bullfrogs and Green Frogs) are generally found close to permanent water. Red-legged Frogs and Wood Frogs will forage in damp forest some distance from water while Leopard Frogs frequent more open meadows. Northern Tailed Frogs are restricted to mountain streams in unlogged areas or forests that have not seen a logger for many years. They will enter the woods on damp days. Other species of frogs and toads in British Columbia will move farther away from water outside of the breeding season. Pacific Treefrogs and Western Toads inhabit meadows or damp woods. Great Basin Spadefoot Toads spend much of their time underground during the summer but they will emerge on humid nights. Northern Chorus Frogs are difficult to locate during the summer and may spend much of their time underground.

When looking for frogs and toads, watch for movements on the ground. Approach the banks of ponds or sloughs slowly. Be patient. Try to observe the animal first to see how it behaves. Try not to stand up or move directly towards the frog but, instead, get down low and approach it obliquely and from behind. Slow movement to approach, followed by a quick grab with the hand, is the route to successful frog catching.

Newts and ambystomid salamanders are also easiest to find on rainy nights in the breeding season when they congregate in breeding ponds. Through most of the year salamanders remain secretive. While rainy days, even in summer, may bring Rough-skinned Newts out while the sun is up, most salamanders are strictly nocturnal and will remain hidden under logs or the bark of dead trees during the day. Salamanders will forage above ground at night or they can be found by turning over fallen logs or dead wood in damp forests. Be sure to replace a turned over log or rock just as it was. Neotenic salamanders and salamander larvae can be caught in ponds by using a dip net or minnow trap.

Salamanders and small frogs can be transported in plastic jars or plastic containers that have holes punched in the lids. Air holes should always be punched outwards. Some damp paper towels should be placed in the container with the animal to retain moisture. Damp moss or free water can be used if necessary but never leave the container completely dry. Large frogs can be kept for a short time in damp cloth bags. Plastic bags

should be avoided if possible. Never place amphibians in direct sun or near hot automobile engines. Keep the captives cool. Note the date and place of capture, such information is valuable and can be sent to the British Columbia Provincial Museum.

The Study of Amphibians

The branch of science that studies amphibians and reptiles is known as Herpetology. Most of what is known about the salamanders, frogs and toads that live in British Columbia is based on information gathered by herpetologists outside of the province. There is ample scope for more study to be done on amphibians in British Columbia. Although much sophisticated behavioural, populational and ecological research is usually done by professionals, a great deal of valuable information can be gathered with no more equipment than a pair of hands and a good book for identification. Large areas of British Columbia have never been properly surveyed for their amphibian inhabitants. These areas include much of the Pacific coast, the northern areas of the province and many mountainous regions. For instance, we do not know for certain if the Cascades Frog, *Rana cascadae*, actually occurs in British Columbia mainly because few people who could identify it have seriously looked for it and reported on their findings. The exact distributions of species in transitional areas such as Johnstone Strait can only be determined with good locality information. This type of information gathering requires accuracy and objectivity. Records must include the date and exact place of capture as well as the names of the collectors and useful habitat information. Locality records are valuable if the species are properly identified and if the records are accompanied by voucher specimens or good photographs that show identifying details.

The courtship patterns of some of our salamanders have never been documented. This is research that needs only a keen eye, resistance to the cold water of their breeding ponds and perhaps a camera for recording the behaviour. The habits of species of amphibians in the northern regions of British Columbia are poorly known. For instance, the length of time the Northwestern Salamander spends as a larva in the northern part of its range is not documented. Good observations on animals in the wild are

rare and extremely useful though many aspects of behaviour can be studied with captives or with pets.

Amphibians are important and valuable animals. Their study has contributed to all branches of biological and medical research and continues to do so. They are important to the natural balance of the living world and they must be protected and conserved in order for them to survive. The greatest threat to the continued survival of most amphibians is the destruction of their habitats by the activities of man. The conservation of amphibians and other wildlife demands knowledge and preservation of their natural habitats.

Further information on amphibians can be had from the books and journals listed at the back of this handbook. Records and specimens should be made known to the Vertebrate Zoology Division of the British Columbia Provincial Museum in Victoria. Other Canadian museums with substantial collections of British Columbian amphibians are the National Museum of Canada in Ottawa, the Royal Ontario Museum in Toronto and the Cowan Vertebrate Museum at the University of British Columbia in Vancouver. Our knowledge of amphibians come from the work of many individuals. Accurate information is a welcome contribution.

Scientific and Common Names

All known species of living things have been given latinized scientific names. The reason why scientific names are in use is so that every species can be precisely delineated from every other species, as well as have its exact relationships to other similar species indicated. This universal system was first devised and applied by Carolus Linnaeus in 1758. Unlike scientific names, which are internationally recognized though subject to change if the reasons are valid, common names are far from standardization. Common names only incidentally reflect taxonomic relationships and often are regional and usually changeable. The English language is not blessed with many names for amphibians. The four words "frog", "toad", "salamander" and "newt" cannot do justice to the immense variety of the world's amphibians. Other languages have other words for these animals. Only scientific names are universal.

A scientific name consists of two parts. The first word is capitalized and indicates the genus to which the species belongs. For instance,

typical toads are in the genus *Bufo* and people are in the genus *Homo*. The second part of the name is not capitalized and indicates the particular species in the genus. As an example, the Long-toed Salamander is *Ambystoma macrodactylum* while the Northwestern Salamander is *A. gracile*. (The genus name can be abbreviated if it has been mentioned previously and if the reference is obvious. Scientific names are always either italicized or underlined.) When referring to a species, both parts of its name must be used. Scientific names may be descriptive, commemorative or, occasionally, just whimsical. Often, the name of the person who originally described the species is put after the scientific name. If the scientific name has since been altered, this person's name is put in brackets. As a complete example, the Wood Frog, which is called "la Grenouille des Bois" in French, is nevertheless always *Rana* (the genus, meaning "frog" in Latin) *sylvatica* (the species in that genus which means "of the woods") LeConte (the person who first described this species).

In this handbook, the currently accepted scientific names have been used as well as the most widely accepted common names. Numerous other common names of more limited acceptance or familiarity have also been listed where appropriate. Many subspecific varieties have been assigned their own common names by various authors but subspecies have not been used here as they tend to make things more confusing.

About the Keys and Descriptions

Diagnostic keys are useful aids for identifying species. A key is simply a series of numbered pairs of statements to be compared with the specimen in question. Each choice of the statement pair leads either to another such pair of statements or, ultimately, to a positively identifying statement for a particular species. There are separate keys for salamanders and for frogs on pages 27 and 59. Most of the pertinent anatomical features to look for are illustrated near the keys. A glossary located at the back of this handbook is provided to explain unfamiliar terms. The keys are "artificial" in that they do not necessarily reflect the true taxonomic affinities of the various species nor do they use the same characteristics that biologists would use in classifying the species. Such a "natural" key

would be very difficult to use without special equipment and training. In practice, all keys for identification are "artificial".

It should be possible to identify amphibians living in British Columbia by referring to the species accounts and illustrations without having to use the keys. Each species account contains notes on identification, life history, behaviour and distribution. The measurements given for the sizes of the animals are all measurements of total length, in millimetres. The standard way to measure an amphibian is from the snout to the vent. With a frog or toad, this measurement is the same as the total length but with a salamander it neglects the length of the tail. The snout to vent measure is widely used because salamanders can lose all or parts of their tails and may regrow them. Total lengths of salamanders are used in this handbook, though, to help give a better idea of the actual sizes of the animals. The length of the tail is expressed as some proportion of the total. It is easy to calculate an average snout-vent length from this information.

One of the characteristics of amphibians is that most species have aquatic larvae or tadpoles that differ considerably from the adults. Descriptions of larvae are given in the species accounts although not all the different larvae are illustrated. More detailed accounts of the larval stages are included for those species of salamanders that may not transform into the adult stage. In many cases, amphibian larvae can be very difficult to identify. The best way to determine the identity of a larva or tadpole is to retain it until it transforms into an adult.

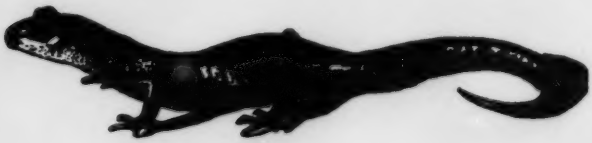
Checklist of British Columbia Amphibians

Rough-skinned Newt	*Taricha granulosa*
Long-toed Salamander	*Ambystoma macrodactylum*
Northwestern Salamander	*Ambystoma gracile*
Tiger Salamander	*Ambystoma tigrinum*
Pacific Giant Salamander	*Dicamptodon ensatus*
Western Red-backed Salamander	*Plethodon vehiculum*
Ensatina	*Ensatina eschscholtzi*
Clouded Salamander	*Aneides ferreus*
Tailed Frog	*Ascaphus truei*
Great Basin Spadefoot Toad	*Scaphiopus intermontanus*
Western Toad	*Bufo boreas*
Pacific Treefrog	*Hyla regilla*
Northern Chorus Frog	*Pseudacris triseriata*
Red-legged Frog	*Rana aurora*
Spotted Frog	*Rana pretiosa*
Cascades Frog*	*Rana cascadae*
Northern Leopard Frog	*Rana pipiens*
Wood Frog	*Rana sylvatica*
Bullfrog	*Rana catesbeiana*
Green Frog	*Rana clamitans*

*Unconfirmed in British Columbia

SALAMANDERS

There are eight families of salamanders living today. Salamanders are found across the northern hemisphere and into the tropics of South America but the majority of salamander species occur in North and Central America. Salamanders range in size from the Giant Chinese Salamander, *Andrias*, that can reach 1½ metres long, to the tiny lungless salamanders, genus *Thorius*, of Central America that may be only as long as a few centimetres, including their tails. Many of the largest salamanders are entirely aquatic. Among these, the Mudpuppy and the Sirens of eastern North America retain the external gills of their larval stages though they may grow very large. Sirens never even grow hind legs. Some aquatic salamanders have adapted to living in caves. These species typically have reduced eyes and have lost their skin pigmentation so that they may appear ghostly white. Many newts and some stream-dwelling salamanders are also highly aquatic when adult. By contrast, some salamanders are entirely terrestrial. Some, like British Columbia's plethodontid species, the Western Red-backed Salamander, Ensatina and Clouded Salamander, never enter the water and no longer have aquatic larvae.



Ensatina

Most native salamanders, though, are terrestrial when adult but have larvae that live in the water. The typical salamander is elongate and smooth-skinned with four legs and a long tail. Along each side is a series of vertical grooves called costal grooves. Usually there are four toes on the front feet and five toes on the hind feet. There are no claws. A newt is a kind of salamander in the family Salamandridae. Newts usually have rougher skins than do other kinds of salamanders and their costal grooves are not as distinct. Salamanders can have teeth not only along the jaws but

also on the roof of the mouth. Vomerine teeth are usually in two rows located just behind the internal openings of the nostrils. Parasphenoid teeth, characteristic of plethodontid salamanders, are in a cluster on the roof of the mouth. These kinds of teeth are named after the skull bones to which they are attached.

Breeding in Salamanders

All salamanders lay eggs, with the exception of three species of European salamanders, genus *Salamandra*, that retain their eggs and give birth to live young. Primitive salamanders of the families Hynobiidae of Asia and Cryptobranchidae of Asia and North America fertilize their eggs externally, just as almost all frogs do. But most newts and salamanders practice internal fertilization in an indirect and unusual manner. Male salamanders do not have copulatory organs and so cannot transfer sperm directly to the reproductive tracts of the female salamanders. Instead, a male lays a small packet of sperm in a jelly capsule called a spermatophore on the ground or pond bottom that the female must pick up with her cloaca. This procedure necessarily involves a great deal of coordination between the mated partners and requires both parties to be ready and willing for successful mating to take place. As a consequence, elaborate mating rituals have evolved that enable salamanders of the same species to recognize each other, prepare each other and position themselves so that successful transfer of sperm can occur. The mating displays of salamanders are complex and fascinating to watch. The rituals may involve clasping (amplexus), nudging, rubbing, chasing or other forms of stimulation and display. Males may have special glands on the chin or elsewhere that produce secretions used in the courtship. Male newts develop black nuptial pads on the feet and legs and high tail fins that in some species are used in elaborate displays. In many terrestrial plethodontid salamanders, the male will lead the female in a "tail-straddling walk" where the female rests her chin on the male's back and walks astride his tail.

The eggs of salamanders do not have hard protective shells or fluid-holding internal membranes. Like all amphibian eggs, they have only jelly coats surrounding them. They must either be laid in the water or be hidden in moist places on land or else they will dry up. Almost all species of salamanders have some sort of larval stage before transforming into

Eggs of Rough-skinned Newt

adults. Salamander larvae do not differ as much from the adult salamanders as tadpoles do from the adult frogs. Like their parents, salamander larvae are carnivorous. Three adaptive types of larvae are recognizable, depending upon where they live. Salamanders that breed in ponds, like newts or species of *Ambystoma*, have larvae with large, feathery external gills and have high tail fins that extend well up the back. These adaptations of such "pond-type" larvae are useful in the still waters where they live, where the amount of oxygen dissolved in the water is low and a large tail fin can aid in swimming. Most pond-type larvae are born with long balancers that stick out behind the head. These are lost eventually. "Stream-type" larvae, such as those of the Pacific Giant Salamander, have much smaller gills. Large gills are not needed in oxygen-rich streams. These larvae have low tail fins to reduce resistance to the flow of water. Terrestrial plethodontid salamanders do not remain long as larvae. Some of these kinds of salamanders have eliminated the larval stage entirely from their life cycles. These "terrestrial-type" larvae, when present, have long branching, not feathery, gills that are resorbed soon after hatching. They have no tail fins at all.

Some species of salamanders may remain larvae for all their lives and will reach sexual maturity while still in larval form. This condition is called neoteny. Neotenic individuals will reach the same size and will live just as long as transformed salamanders but will not metamorphose. In British Columbia, the Northwestern Salamander, Tiger Salamander and Pacific Giant Salamander are all frequently neotenic.

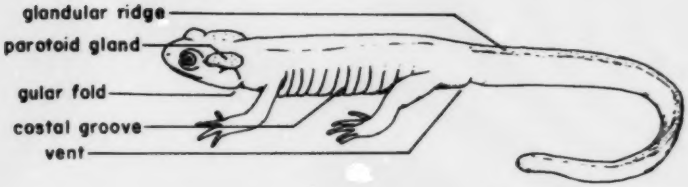
Eggs of Northwestern Salamander

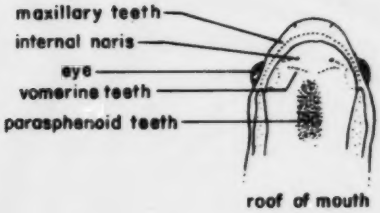
Regeneration in Salamanders

Many salamanders possess considerable powers of regeneration. They can grow back lost toes, whole limbs and parts or all of their tails. This ability is obviously very useful. If part of the tail is lost to a predator, it can be grown back. The Ensatina actually waves its tail at a potential enemy. The salamander can break off the tail if the predator attacks it and so escape. A new tail will regrow.

Regeneration of extremities is actually a widespread phenomenon among vertebrate animals, at least in the early stages of their development. An adult frog is incapable of regrowing a lost limb but a tadpole can replace one. Even new-born mammals are capable of regrowing the last segment of a finger if it should be lost in an accident. Salamanders are unusual in that they retain regenerative abilities as adults.

The process of regeneration involves reorganizing of the cells left in the stump. At first they regress into an embryonic-like condition. These cells then multiply and redifferentiate into the kinds of tissues that were lost. Initially, a bud or "blastema" is formed over the wound then, as the tissues continue to redifferentiate, the new limb or tail is formed. The process is still not completely understood. The growth of regenerating tissues has many similarities to the growth of cancers. The study of regeneration in salamanders is an important part of embryology and medical research.





Characteristics of salamanders

Artificial Key to Living Adult Salamanders of British Columbia

1a. Skin rough and tuberculate, belly bright orange, no obvious costal grooves ..... *Rough-skinned Newt* ***(Taricha granulosa)***

1b. Skin smooth, costal grooves evident 2

2a. Nasolabial groove running down from each nostril, parasphenoid teeth present 3

2b. No nasolabial grooves or parasphenoid teeth 5

3a. Smooth-edged red or orange dorsal stripe continuing to tip of tail, rarely without stripe, 15 costal grooves ..... *Western Red-backed Salamander* ***(Plethodon vehiculum)***

3b. No dorsal stripe 4

4a. Tail constricted at base, yellow colour at limb bases, no markings on back, 12 costal grooves ..... *Ensatina* ***(Ensatina eschscholtzi)***

4b. No constriction at base of tail, mottled colour pattern, 15 costal grooves ..... *Clouded Salamander* ***(Aneides ferreus)***

5a. Irregular green or yellow dorsal stripe breaking up on the head and tail, white speckles on sides and belly, 12 costal grooves ..... *Long-toed Salamander* ***(Ambystoma macrodactylum)***

5b. No dorsal stripe, length more than 120 mm .....

6a. Blotched yellow (or white) and black pattern, foot tubercles present, 13 costal grooves ..... *Tiger Salamander* ***(Ambystoma tigrium)***

6b. Foot tubercles absent 7

7a. Colour dark brown with or without black specks, parotoid glands and glandular ridge on tail present, 10 to 12 costal grooves ..... *Northwestern Salamander* ***(Ambystoma gracile)***

7b. Marbled brown pattern, no parotoid glands or glandular ridge on tail, 12 costal grooves ..... *Pacific Giant Salamander* ***(Dicamptodon ensatus)***

FAMILY SALAMANDRIDAE — Newts

Rough-skinned Newt ***Taricha granulosa*** (Skilton)

(Pacific Coast Newt, Western Newt)

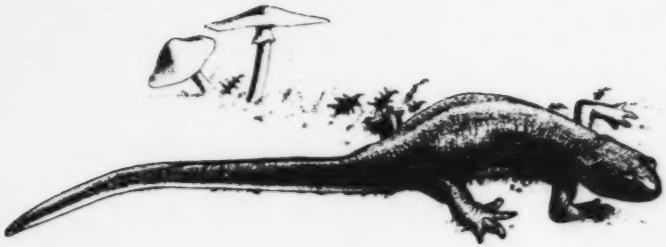
Although all amphibians possess some sort of noxious or poisonous skin secretions for defense, this newt and its related species in the same genus has by far the most potent skin toxin of any North American amphibian. The active ingredient, called Tetrodotoxin, swiftly blocks nerve impulses if experimentally injected. But there is nothing to fear from these docile and engaging animals, the poison is purely for defense and is released only if the newt is severely agitated.

Distinguishing Features — Newts, in general, can be distinguished from other salamanders by the lack of distinct costal grooves on the sides of their bodies. The Rough-skinned Newt is easily identified by its granular, uniformly brown dorsum and bright orange belly.

Description — This is a long-legged, solid brown salamander with slightly flattened fingers and toes. The entire body surface is roughened with small tubercles. The Rough-skinned Newt is dry to the touch, in contrast with other salamanders which are smooth skinned and often slippery. The eyes are small and are not very protruding. The jaws jut out at the back of the head giving the rear of the head a square shape. There is no gular fold across the throat. The belly is orange and unmarked. The tail is compressed laterally towards the tip.

Male newts can be distinguished from females by their longer tails, longer legs and more swollen vents. In males the dorsal pigment usually extends across the vent in a dark band. The differences between the sexes become accentuated in the breeding season. Males become very aquatic and develop smoother skins and enlarged tail fins. Dark nuptial pads develop on the palms, soles and legs and the vent swells even more. These physical changes do not occur in the females. Rough-skinned Newts can be 120 to 180 mm in length. The tail takes up about ⅝ of that length in males and about ⅜ in females.

Newt larvae are pond-type larvae. They have blunt heads and single rows of yellowish dots along the sides. Very young larvae have balancers behind the head. They transform in late summer when about 50 to 70 mm long.



Rough-skinned Newt

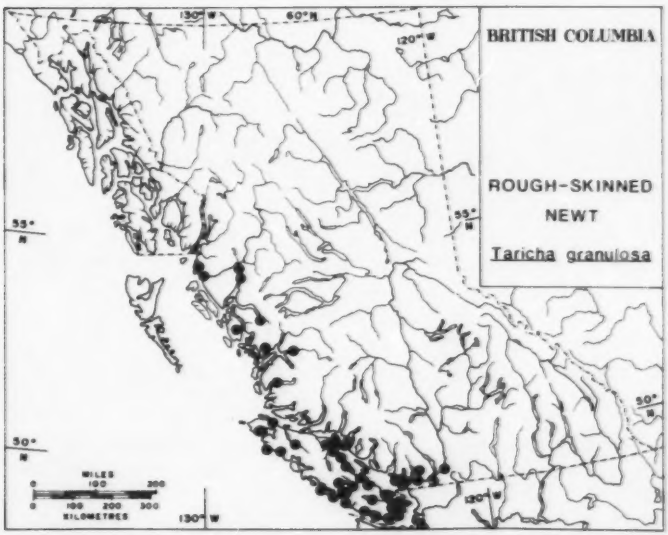
Habits — Rough-skinned Newts can be common in mixed forests, usually near permanent ponds or swamps. They prefer rather open woods with a good deal of deadfall and litter. They do not seem to like dense, damp cedar forests. Newts are not so secretive as are other salamanders and may be abroad in the daytime, especailly on warm, cloudy or rainy days. They can be quite aquatic. Rough-skinned Newts move slowly and make little attempt to hurry if they are bothered. When severely distressed by being struck or grabbed they will arch their backs, bringing the tail and head up to expose their bright orange bellies, and remain immobile in that position. They make no attempt to bite. Their toxic skin secretions are enough to prevent almost any predator from attempting to try and eat one more than once and preclude any necessity to protest more vigorously. Common Garter Snakes, *Thamnophis sirtalis*, which are known to have high resistance to many amphibian poisons, have been reported to eat Rough-skinned Newts. Rough-skinned Newts, in turn, eat soft-bodied invertebrates such as slugs and worms, as well as aquatic invertebrates and tadpoles.

Breeding—As in many salamanders, the courtship of Rough-skinned Newts is an elaborate ritual. The aquatic male in breeding condition will locate a female in the breeding pond mainly by smell. When he finds a mate he will grab her in pectoral amplexus. In this position, riding on top

of the female, the male will stroke her sides with his hind feet while rubbing his chin on her nose. There is a gland on the male's chin whose secretion play a role in the courtship. With his powerful tail, the male can control the female and maneouvre her away from other males. He is not always successful in this and sometimes many males will try to grab the same female. Eventually, the male will let go of the female and dismount, swimming ahead. As the female nudges his vent he deposits a spermatophore on the pond bottom. The male then walks forward and bends his body to guide the female with his tail into the proper position for her to pick up the spermatophore packet with her cloaca.

The eggs are laid shortly after mating. They are attached singly to aquatic plants. The larvae eat small aquatic invertebrates and may take one or two seasons to transform.

Newts breed in early spring in shallow ponds, bogs and swamps. Large numbers of them will migrate to their breeding sites on warm, rainy nights in spring.



Range—Found along the western coast of North America, west of the Coast and Cascades mountains, from near Anchorage, Alaska to San Francisco Bay. An isolated pocket exists also in northern Idaho. In British Columbia it is found among the forests of the coast, up the Fraser Valley to Hope, and on Vancouver Island and the Gulf Islands.

FAMILY AMBYSTOMIDAE—MOLE SALAMANDERS

Long-toed Salamander ***Ambystoma macrodactylum*** Baird

Adult ambystomid salamanders such as the Long-toed Salamander, are not often seen, except in their breeding season, because they spend large amounts of their time underground. The salamanders themselves, though, may have only limited burrowing abilities. Instead, they often hide in the abandoned burrows of rodents or natural hollows and crevices. All Mole Salamanders have aquatic larvae.

Distinguishing Features—The Long-toed Salamander has an irregular light green or yellow stripe along the back that breaks up into spots and patches before it reaches the tip of the tail. When the limbs are adpressed against the side of the body they meet or overlap slightly. There is no nasolabial groove.

Long-toed Salamander

Description—The background colour is dark grey or black. A prominent but irregular stripe of green or yellow runs down the back from the top of the head and along the tail. In southwestern British Columbia and on Vancouver Island, the dorsal stripe is usually greenish with diffuse and indefinite edges. Long-toed Salamanders in the Rocky Mountains region tend to have bold, bright, yellow stripes that break into patches on the head while those from the rest of the province have continuous yellow stripes from the tip of the snout to the tail. The sides and belly are lighter grey with numerous white speckles. The head is oval with a blunt snout and large, prominent eyes. There are no parotoid glands. A gular fold is present. The legs are strong and have slender, unwebbed toes on the feet. There are small tubercles present on the soles of the feet. There are usually 12 costal grooves on the sides of the body. Adpressed limbs either meet or overlap by up to two costal grooves. This is a medium-sized salamander ranging from 80 to 120 mm in length. The tail occupies slightly more than half of that amount. Males have slightly longer tails and have larger vents than females. Juveniles are often more brightly coloured than the adults and have fewer white speckles of the sides and belly.

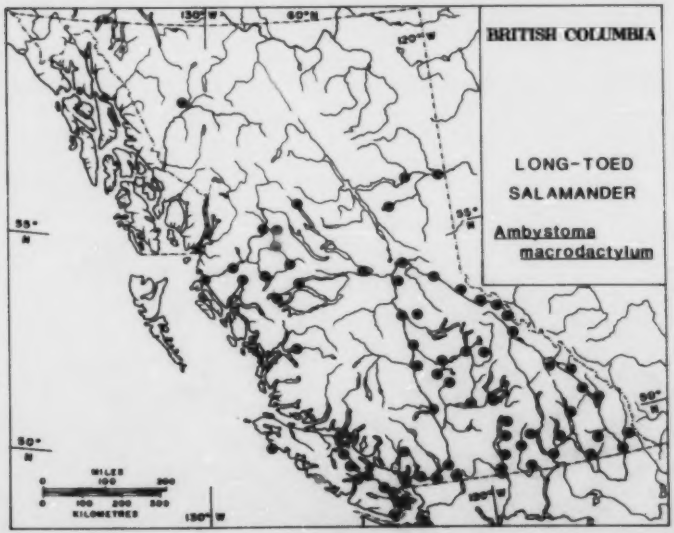
The larvae are grey or light brown pond-type larvae. The body is flecked with darker brown or black and has a silvery underside. Larvae reach 70 mm before transforming.

Habits—The Long-toed Salamander is at home in a variety of habitats but prefers damp areas at forest margins where there are ample opportunities to hide, generally not far from standing water. Adults remain hidden throughout most of the year underneath rocks, logs or boards, in abandoned burrows or in crevices in rock piles. Occasionally they may stumble into basements or cellars through foundation cracks or open windows. Most of their activity above ground occurs in the spring or fall during wet weather. The food of the Long-toed Salamander consists of small invertebrates and insects.

Breeding—Mating activity occurs in the early spring, often before the ice on the breeding ponds has had a chance to completely disappear. The

Long-toed Salamander breeds in shallow, permanent ponds that have a fair amount of aquatic vegetation. The courtship pattern is similar in some ways to the courtships of the Rough-skinned Newt and Northwestern Salamander. The male will unceremoniously grab a female in pectoral amplexus and rub his chin on her nose so that she will smell the secretions of his chin gland. The male Long-toed Salamander does not use his hind legs to hold on to the female as is sometimes the case in the Northwestern Salamander. After a while, the male breaks off amplexus and swims about one body length ahead of the female to lay his spermatophore. Then he leads the female forward so that she may pick it up. Once this performance is finished, the male may swim off to find another mate or may turn around and grab the same one again. Many spermatophores may be laid by a male during a round of courtship and mating.

The female will lay her eggs soon after mating. They are sometimes laid singly but are usually laid in small clumps and are attached to underwater vegetation. The eggs hatch in two or three weeks. At high elevations and in far northern regions of British Columbia the larvae



probably over-winter and transform the following summer. Long-toed Salamanders reach maturity in two or three years.

Range—Found from southern Alaska across most of British Columbia west of the Rockies through Washington, Idaho and western Montana to Oregon and northern California. In British Columbia it is found throughout the province, excluding much of the far northern and Peace River regions and the Queen Charlotte Islands from its range.

Northwestern Salamander ***Ambystoma gracile*** (Baird)
(Brown Salamander)

Frequently, the larvae of the Northwestern Salamander may fail to transform to the terrestrial adult stage and will breed as permanent larvae. This condition is known as neoteny (or paedogenesis) and may occur under special environmental conditions in other species of Mole Salamander as well.

Distinguishing Features — This is a robust, chocolate-brown salamander with distinct parotoid glands behind the eyes and a glandular ridge on the top of the tail.

Description — This is a large and chunky salamander that is generally a deep brown colour. There may be dark patches or yellow specks on this

Northwestern Salamander

brown background, more predominately among individuals in the northern parts of the range. The belly is a lighter shade of brown. The head is wide with small, slightly protuberant, brown eyes. The oval parotoid glands behind the eyes on the top of the head are usualy obvious. They are a slightly lighter colour than the rest of the body and are bounded by indented grooves. There are 10 to 12 costal grooves on the sides of the body. The legs are well developed and will overlap by about six costal grooves when adpressed against the body. The laterally compressed tail has a glandular ridge that is similar in appearance to the parotoid glands and runs along the top of the tail. There are no tubercles on the soles of the feet. Northwestern Salamanders can be from 150 to 200 mm long. The tail takes up about half this in females and slightly more than half in males. Males also tend to have longer legs than the females and in the breeding season they develop swollen vents.

The pond-type larvae of the Northwestern Salamander have large, feathery gills and large tail fins that extend along the back as far as the head. They are grey or brown overlaid with yelow, green and black mottling. The glandular ridge on the tail is present in the larvae. They will transform when between 75 and 120 mm long but permanent, neotenic larvae will reach the same size as the transformed adults.

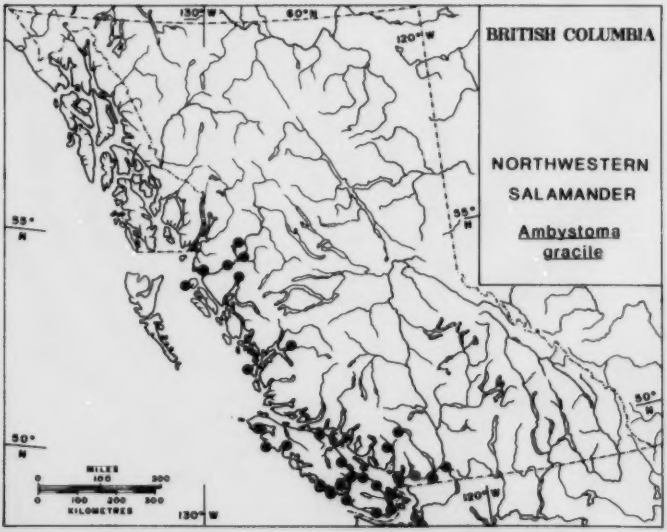
Habits — Adult Northwestern Salamanders are not often seen. They seem to prefer forest margins and pond banks but probably spend most of their time hidden underground beneath the leaf litter of the forest or under rotten logs or boards. They are usually encountered in the early spring when breeding takes place and they are migrating to the breeding ponds. If it is severely disturbed, a Northwestern Salamander will exude the milky white poison from its parotoid and tail glands. It may assume a defensive posture by rising up on its legs while lowering its head and lashing its tail back and forth. These salamanders eat slugs and other soft-bodied invertebrates.

Through most of the year, the larvae of the Northwestern Salamander are much more often found than are the adults. Larvae can be found at any time of the year because they generally take more than one season to transform, if they transform at all. Permanent, neotenic larvae will attain sexual maturity without metamorphosing. They breed at the same time as transformed individuals and the two forms will mate with each other. The

incidence of neoteny in the species is almost certainly related to environmental conditions; its cause requires further investigation. Neoteny is most frequent among salamanders living in large, stable ponds or in lakes, especially at high altitudes.

Breeding — The adults migrate to shallow and moderately vegetated ponds or lakes in early spring to breed. They require permanent or semi-permanent ponds located near woodlots or forests. The ponds are usually devoid of large fish that might eat the eggs or growing larvae. In the water, the male will grab a female in amplexus with one or both pairs of legs and will rub his chin over her nose repeatedly. On occasion, he will dismount and nudge her or butt her with his head. After the male has swum forward and deposited his spermatophore on the pond bottom he will gently stroke the female with his tail while she picks it up. Up to 30 spermatophores may be laid by a single male.

Later, the female will lay a mass of eggs that will swell to about the size of a baseball around a submerged stem or twig. Often the egg mass will be

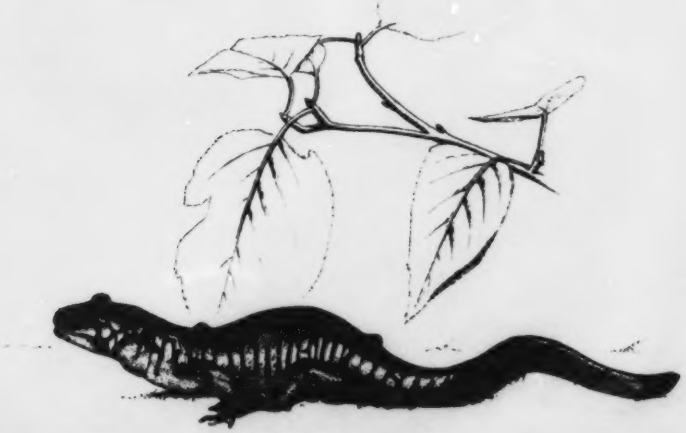


given a green tinge by algae growing in the jelly. The algae does not harm the developing eggs and may help to provide them with oxygen. The young hatch in about a month. Empty jelly masses may often be seen floating in the pond until late in the summer. The larvae take at least a year to transform and take a further two or three years to reach sexual maturity.

Range — Found along the Pacific Coast to the west of the Coast and Cascades mountain ranges from extreme southern Alaska to the northern California Coast. In British Columbia, it occurs all along the west coast and on Vancouver Island.

Tiger Salamander ***Ambystoma tigrinum*** (Green)

This is the most widespread salamander species in North America and is one of the few that is capable of tolerating the dry conditions of many regions in the interior of the continent. It is extremely variable in its markings and many subspecific varieties are recognized.



Tiger Salamander

Distinguishing Features — This is a large salamander that is smeared with yellow and black to form irregular blotches or vertical stripes. Two tubercles are present on the sole of each foot. There are no parotoid glands present.

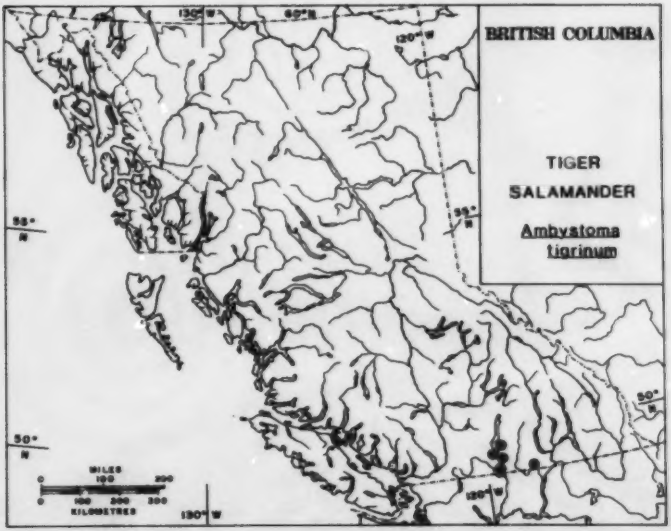
Description — The Tiger Salamander in British Columbia has large blotches of yellow or dirty white on a black, grey or dark brown background. The borders of the blotches are often indistinct or they might join in such a way as to form a zebra-like pattern. The blotches extend down the sides and are not confined to the back nor do they ever form a distinct dorsal stripe. The belly is dirty grey while the legs and tail are mottled with light and dark patches. The head is round and relatively short but may have a pronounced snout. The eyes are fairly small and are widely spaced on the sides of the head. There are usually 13 costal grooves on the sides of the body. The well-developed legs overlap by three or four costal grooves when adpressed along the body. Each foot has two tubercles on the sole. Males have slightly longer tails than females and have swollen vents in the breeding season. Adult Tiger Salamanders may be as much as 200 mm long but generally average between 140 and 180 mm; the tail makes up about half this.

The larvae of the Tiger Salamander are pond-type and have large gills and tail fins but unlike the pond-type larvae of other British Columbia salamanders, they do not have balancers behind the head when young. The head is depressed and the eyes are rather small. The larvae of Tiger Salamanders may reach 75 to 80 mm before transforming. Neotenic individuals may occur in some localities, especially in deeper ponds or lakes.

Habits — Tiger Salamanders inhabit the dry southern interior of the province and are usually found near small, frequently alkali, lakes and ponds. Their ability to resist periods of drought is due to their subterranean habits. During the summer they hide below ground in abandoned burrows or in other hollows. Generally, they are active near the surface only at night during or just after spring or fall rains. Otherwise, the adults are rarely seen. Their food consists of earthworms, insects or molluscs as well as the occasional frog or baby mouse. Neotenic Tiger Salamanders may live in deep, permanent pools. They will eat small fish, aquatic insects and worms or other larval Tiger Salamanders.

Breeding—In early spring Tiger Salamanders migrate to nearby permanent or semi-permanent lakes and ponds to breed. There is no amplexus, instead courtship consists of much nudging, pushing and lashing of tails. Finally, the male will crawl ahead of the female and, lifting his tail, lay a spermatophore for the female to pick up. There is a great deal of competition for mates when the salamanders congregate together. Males try to push and shove their chosen ones to more secluded spots but males will often interfere with one another's courting. Males also tend to lay their spermatophores on top of other spermatophores to cover them up. Many spermatophores are produced by a male during a bout of courtship.

Eggs are laid shortly after mating, sometimes singly and sometimes in small masses. They are attached to stones, twigs or plants. The eggs hatch in two to three weeks. The larvae grow rapidly and transform in three to four months. They usually prefer warm areas of the pond where there is considerable growth of algae to hide in. The larvae eat aquatic insects and



invertebrates and are not above cannibalism. Neoteny is frequent in the Tiger Salamander in many parts of its range.

Range—Found across the United States, except the northwest coast and the Appalachians, and north into the Canadian prairies and south down through eastern Mexico. In British Columbia, it enters the Okanagan Valley, reaching as far north as Summerland.

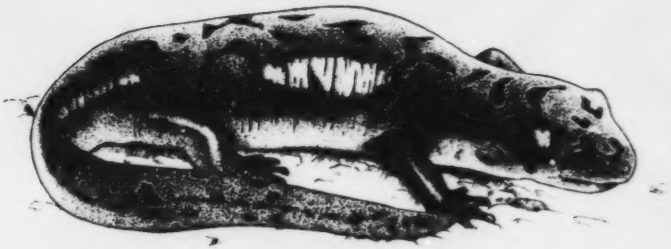
Pacific Giant Salamander ***Dicamptodon ensatus*** (Eschscholtz)

The Pacific Giant Salamander is the only stream-dwelling salamander in British Columbia. Its larvae are streamlined and adapted to life in flowing water. This is one of the few salamanders to possess a true voice.

Distinguishing Features—Any large salamander from the hills surrounding the Fraser Valley area with prominent light and dark brown marbled markings is certain to be this species. They have no parotoid glands or foot tubercles.

Description—This is a large and robust salamander whose obvious light and dark brown markings on the head, back and sides form a reticulate marbled pattern. Light halos surround the dark patches. These markings may be a bit faded in older specimens. The belly is a light tan or flesh tone. The moderately broad head has a short, blunt snout and medium-sized eyes that have brass-flecked irises. A gular fold is present. There are no parotoid glands. The body is stout. The legs are large and strong. The feet do not have webs and do not have any tubercles on the soles. There are generally 12 rather indistinct costal grooves on each side. Adpressed limbs overlap. The tail is stout and laterally compressed towards the tip. Males have slightly longer tails than females. This is the largest salamander in British Columbia and may reach a total length of about 300 mm, although its usual size falls between about 150 and 250 mm. About ⅔ of the length is the tail.

The larvae of the Pacific Giant Salamander are stream-type larvae. They have small, fuzzy gills behind the head and a short fin confined to the tail. Though there is a light stripe extending from the eye to the angle of the jaw, otherwise the larvae are light chocolate brown without obvious markings. The face is short and broad. The larvae will transform when



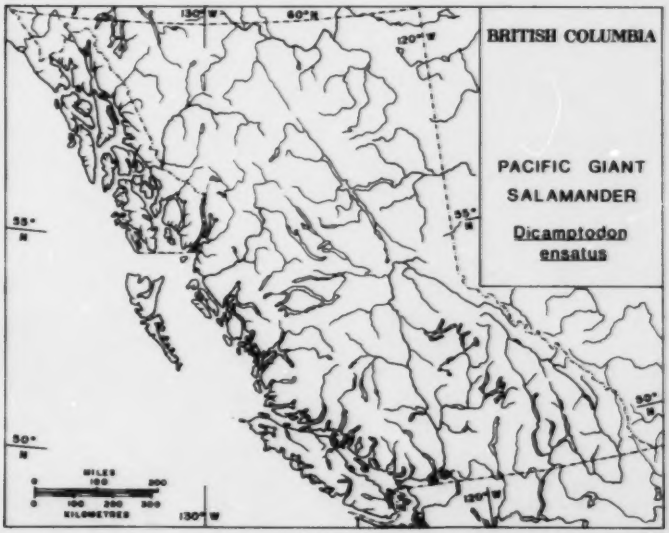
Pacific Giant Salamander

between 150 and 200 mm, if they transform at all. Neoteny is frequent in this species and permanent larvae may reach large size. Transformed adults are actually rather rare in British Columbia.

Habits—Pacific Giant Salamanders are restricted to unlogged Douglas-fir and Big-leaf Maple forests on the slopes of hills or mountains. They rarely venture too far from clear, fast-flowing, creeks and usually hide under logs or rocks by the stream. They will occasionally forage during daylight in wet weather. If molested, they can "bark" or "yelp". With their large size, they appear quite formidable. They are harmless, though, even if they do try to bite. Their food is made up of slugs, insects, frogs, other salamanders or the occasional small mammal. Pacific Giant Salamanders will also eat garter snakes, those otherwise implacable enemies of amphibians. The larvae and neotenic adults are voracious predators of other amphibian larvae such as the tadpoles of the Tailed Frog.

Breeding—Pacific Giant Salamanders breed in the spring. Their courtship pattern is not fully known although it is known that the males will deposit many spermatophores during courtship, as do many other ambystomid salamanders. The females will lay about 100 or more eggs which are laid singly and are stuck to the underside of a rock in a creek or stream. The eggs are colourless and are attached to the rock by a small pedicle or stalk. Usually, the female will remain with her eggs during their development until they hatch in the fall. The larvae grow slowly and may not transform until their second or third year or they may remain as neotenes.

Range—Found along the west coast of North America from extreme southern British Columbia to northern California. There is an additional, disjunct range in Idaho and western Montana. In British Columbia, they are known only from near Cultus Lake and Chilliwack Lake in the Fraser Valley.



FAMILY PLETHODONTIDAE—LUNGLESS SALAMANDERS

Western Red-backed Salamander ***Plethodon vehiculum*** (Cooper)

None of the members of the large family of plethodontid salamanders have lungs although all breathe air as adults. Respiration is carried out through the skin and through the lining of the mouth. The throat of a lungless salamander pumps up and down, as it does in any other air-breathing salamander, but this serves only to push air in and out of the mouth cavity. There is no visible movement of the salamander's sides because there are no lungs inside to inflate and deflate.

Western Red-backed Salamander

Distinguishing Features—The Western Red-backed Salamander has an unbroken, smooth-edged, bright red or orange stripe along the back and tail. This is a slender salamander with short legs. The legs do not meet if they are adpressed along the side of the body. Nasolabial grooves are present.

Description—An unbroken, broad red or orange stripe extends along the back from the snout to the tip of the tail. Occasionally, one may be found whose stripe is yellow or tan or so dark as to be inconspicuous. The sides and belly are dark bluish grey with spots and flecks of white or yellow. The Western Red-backed Salamander is slender. The tail is about the same diameter as the body for most of its length. There are usually 15 or 16 costal grooves on the sides of the body. The head is long and parallel-sided with a rounded snout and the eyes are placed well forward on the head. There is a prominent gular fold under the neck. The legs are comparatively short. There remain five or six costal grooves between the limbs adpressed against the body. Males and females are similar. The length of this salamander can be from 80 to 150 mm. The tail is about as long as the distance from the snout to the vent, half of the total length. There is virtually no free-living larval stage of this species.

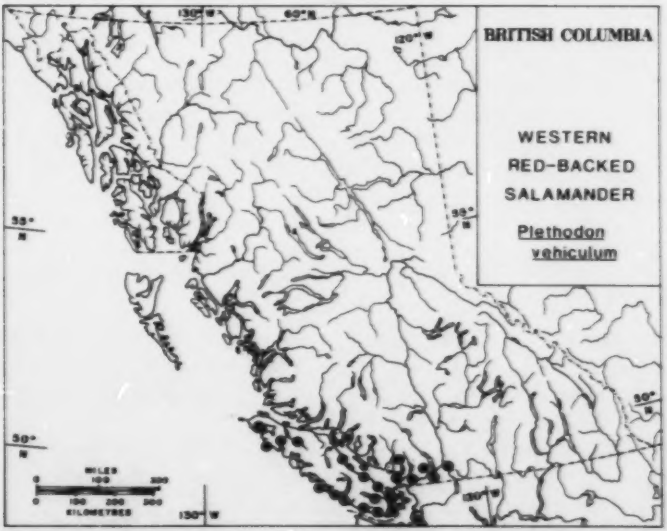
Habits—Western Red-backed Salamanders are entirely terrestrial. They have little need for ponds, lakes or pools of standing water. They can easily drown if they are unable to crawl out of even shallow water. They do require moisture, however. Like all lungless salamanders, they rely on their skins for most of their respiration and therefore the skin must be kept moist and in contact with the air. Western Red-backed Salamanders frequent damp woods and live among the leaf litter and damp forest debris of Douglas-fir stands. They can generally be found under moss, rocks, fallen logs or leaves in damp, but not wet, shady areas of the woods often near or beside streams. They are primarily insect eaters, consuming mostly termites, springtails, and other ground-dwelling arthropods.

Breeding—Breeding activity begins in the late fall. The courtship pattern of the male involves, first, his nudging or rubbing the female with his chin, followed by a "tail-straddling" walk in which the female rests her head on the male's lower back and follows along behind him while walking on either side of his tail. While they are in this position, the male

lays his spermatophore on the ground and leads the female forward to pick it up. Only one spermatophore is laid by a courting male. The female stores the sperm internally in a spermatheca until she lays her eggs in the spring. Courtship and mating occur entirely on land.

The female finds a hollow underground or among damp rocks in which to lay eight to 15 round, unpigmented eggs. She stays with her eggs until they hatch. Such brooding behaviour is common among terrestrial plethodontid salamanders and helps to prevent the eggs from drying out or from being attacked by fungus. The larval salamanders develop within their eggs and hatch in an advanced stage. The gills and yolk supply, that sustained the larvae inside the egg, do not persist for long after hatching. The young emerge from the nest in early fall, when they are about 25 to 30 mm long, and mature in about two years. The females appear to breed every second year.

Range—Found west of the Coast and Cascade mountains from southwestern British Columbia to southwestern California. In British Columbia, it is found throughout Vancouver Island, on the adjacent mainland, and through the Fraser Valley to Hope.



Ensatina ***Ensatina eschscholtzi*** Gray
(Oregon Salamander, Red Salamander)

The Ensatina has many colour forms that occur in the various parts of its range. This handsome species reaches its maximum variability in California where the subspecies range in colour from solid brown to brown with yellow and black mottling to black with orange bands. Different forms may have yellow eyes or brown eyes. Most of the varieties can interbreed; some cannot, or do so only rarely. In British Columbia, only one, evenly coloured form occurs.

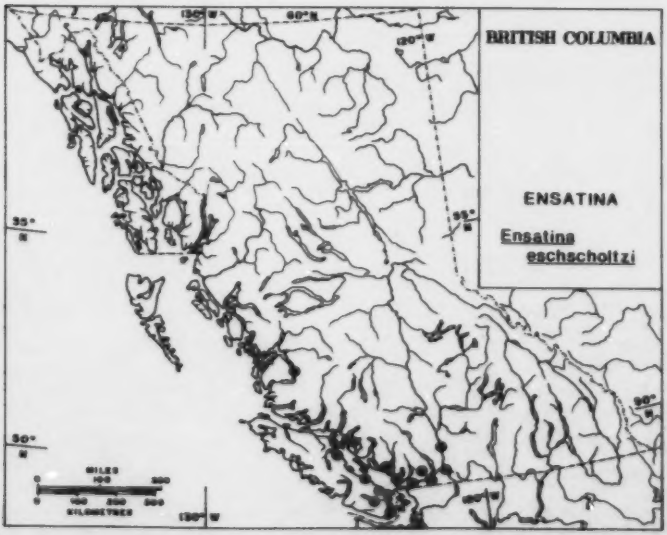
Distinguishing Features—The Ensatina in British Columbia can be distinguished from other salamanders in the province by its uniform brown colour, constriction at the base of the tail and lack of parotoid glands. Nasolabial grooves are present.

Description—In British Columbia, the Ensatina is evenly coloured medium brown to pinkish tan. There are no large spots, stripes or blotches although the sides may be mottled with yellow or brown flecks. The bases of the limbs are yellow, as are the feet. The belly is pinkish, covered with scattered, dark speckles. The hooded, brown eyes are large and prominent, giving the animal a rather sad expression. The snout is rounded. A nasolabial groove running down from each nostril to the mouth is easily discernible. There is a well developed gular fold. On each side of the body there are 12 costal grooves. The spindly legs, when adpressed alongside the body, meet or overlap by up to three costal grooves. The tail is rounded in cross-section and has a definite constriction at the base. A glandular ridge runs along the top of the tail. Males have slightly longer tails than the females. Ensatinas can be from 80 to 120 mm long; about half of that length is tail. Juveniles are similar to the adults but tend to have more light and dark flecking on the sides. There is no free-living larva.

Habits—The Ensatina is entirely terrestrial and never resorts to standing water. They prefer damp woods with considerable leaf litter and debris to hide among. During damp weather they can be found under rocks, boards or logs but they will retreat into moist crannies in logs or between rocks when conditions are drier. Like most salamanders, they are largely nocturnal.

Ensatina

If frightened suddenly, or disturbed, an Ensatina will rear up stiffly on all four legs and wave its tail in the air. The glands on the dorsal side of the tail secrete a white, noxious poison for defense. The tail is easily broken off at its basal constriction. A potential predator that grabs the tail will be left with a writhing, foul tasting tail but no salamander. A new tail will grow back in time.



The food of the Ensatina consists of small arthropods and insects. The sticky mushroom-shaped tongue is attached to the floor of the mouth by a stalk, and can be protruded to catch food.

Breeding—Mating seems to occur in the early spring. During courtship, the male Ensatina slowly approaches the female and rubs her head and throat with his head. He then manoeuvres in front of her and leads her in a "tail straddling" walk that may last for many hours. During this promenade, the female rests her chin on her mate's lower back. At length the male stops and, rocking his hips back and forth, lays his spermatophore on the ground. He leads the female forward so that she may pick it up with her cloaca as he caresses her with his tail.

In late spring the female lays a cluster of about ten colourless eggs in an underground chamber or rotted log. She broods them all summer. The young salamanders hatch in the fall, fully developed, having gone through all the developmental stages within the egg.

Range—Found from southwestern British Columbia to extreme southern California to the west of the Coast and Cascade mountain ranges. In British Columbia, it is found on the eastern half of Vancouver Island and on the adjacent mainland to South Bentinck Arm and up the Fraser Valley to Boston Bar.

Clouded Salamander — *Aneides ferreus* Cope

The Clouded Salamander has an unusual, interrupted distribution. It is found on Vancouver Island and in Oregon but not on the intervening mainland of British Columbia and Washington, except for a few records from the Fraser Valley. Perhaps populations of this salamander were trapped in two separate refuges during the past Ice Age.

Distinguishing Features—This is a brown salamander with diffuse light grey or bronze patches or speckles. There is no dorsal stripe in the adult and no constriction at the base of the tail. Nasal labial grooves are present.

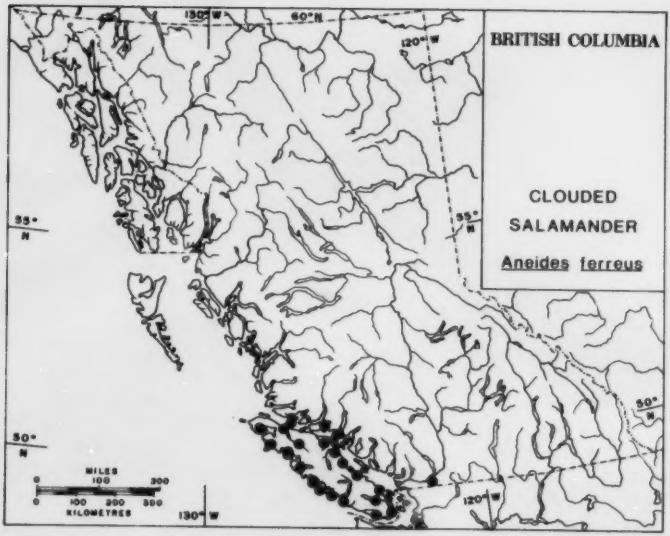
Description—The Clouded Salamander is dark brown with numerous greyish or bronze-coloured blotches, patches and speckles covering the

Clouded Salamander

head, back and tail. A bronze dorsal stripe in juveniles disappears with age. There is usually a large bronze patch on the head and snout. The belly is grey with yellowish flecks. The head is large and somewhat triangular, due to the large jaw muscles. The eyes are large, bright and protuberant. As in all lungless salamanders, there is a nasolabial groove running down from each nostril. The upper teeth project over the lower jaw and can be felt by running a finger under the snout. The line of the mouth bends up and then down again as it runs along the side of the face giving the salamander a sort of insipid, buck-toothed smile. There is a prominent gular fold across the throat. The legs are long and the toes are distinctly squared at the tips. While the innermost toe of each foot is rather small, the rest of the toes are fairly long. There are 15 costal grooves on each side of the body. If the legs are adpressed along the body, the digits of the front and back feet will barely meet. The hind feet are slightly webbed.

Clouded Salamanders may be from 80 to 110 mm long, the tail is about ⅔ of the length. The males and females are similar in appearance. This species has no free-living larva.

Habits—The Clouded Salamander inhabits damp, mossy Douglas-fir forests. It is entirely terrestrial and is usually to be found in rotting logs or underneath the bark or moss covering dead trees or stumps. It is an active and agile salamander that will often climb trees to considerable heights. It



is largely nocturnal and is most active during wet weather. Its food consists of ants, springtails, mites and other ground-dwelling arthropods.

Breeding—Mating activity probably occurs during the early spring. The courtship is pursued on land and follows a pattern similar to the courtships of other terrestrial plethodontid salamanders. Females lay their eggs in late spring in rotting Douglas-fir logs. Other species of trees seem to be shunned as possible sites for nests. The eggs are colourless and dangle from the roof of the nest on the ends of long, entwined stalks. They are laid in clusters of about 10 to 20 eggs. The female stays with her eggs until they hatch in the fall. The attending mother will eat any dead or infected eggs and so help prevent fungus or disease from spreading through the clutch. The young go through their entire development within their eggs in about nine weeks and hatch ready to fend for themselves on land. Inside the eggs, the embryo salamanders develop long, branching gills that press close to the egg membrane and enable them to respire

through the egg capsule. The gills are resorbed just before hatching. Clouded Salamanders mature in one or two years. Females apparently breed every second year.

Range—Found on Vancouver Island, and in Oregon and northern California west of the Cascade mountains. In British Columbia, they appear to be rare on the mainland although they occur throughout Vancouver Island.

FROGS AND TOADS

Nearly 2,800 species of frogs, toads and treefrogs in 27 families make up the order Anura. Collectively, they can all be referred to as "frogs" and all of them share physical modifications designed for jumping or hopping. Frogs have developed enlarged, muscular hind legs and have lost their tails. Their skeletons are markedly reduced and lightened. Advanced frogs have only seven vertebrae and no ribs. In this regard, the Tailed Frog is considered to be quite primitive because it retains free ribs and tail-wagging muscles as an adult, and has nine vertebrae. In all frogs, the bones of the skull are reduced and the bones of the forearm and calf are each fused into single bones. The number of teeth is also reduced. There are no teeth on the palate, as in salamanders. Most frogs have teeth only on the upper jaw; some, like the toads, have no teeth. All of the structural characteristics of frogs make them easy to recognize as such, yet there is an astounding array of variation among them.

Frogs range in shape from the globular Rain Frogs, *Breviceps*, of southern Africa, whose legs are so short that the male cannot clasp the female when mating and instead glues himself to her back to hold on, to the long-legged, gangly treefrogs of the genus *Phyllomedusa* of South America who climb through the trees by grasping branches with opposable thumbs and toes. The Mexican Burrowing Toad, *Rhinophrynus*, has a tiny mouth and feeds mainly on termites while the Horned Frogs, *Ceratophrys*, have huge heads and mouths and eat other frogs, as well as small mammals. Horned Frogs are belligerent and will try to attack and bite their enemies, a marked contrast to the timidity of most frogs. The Goliath Frog, *Conraua*, of the Cameroons can be over 300 mm in length while the smallest of frogs, *Sminthillus* of Cuba, is no more than a centimetre long when fully grown. Some frogs are experts at camouflage. *Megophrys* from southeast Asia looks exactly like a few dead leaves.

Other frogs may be dazzlingly coloured. The Poison-dart Frogs, genus *Dendrobates*, may be brilliant red, gold, purple and black. The Golden *Mantella* of Madagascar is glowing orange with deep red eyes. The Coroboree Toadlet, of the genus *Pseudophryne* from Australia, is boldly marked in vibrant yellow and black. And, while almost all frogs have large, bright eyes, burrowing frogs like the Turtle Frog, *Myobatrachus*, from the Australian outback, may have tiny eyes half hidden on top of the head. All of these are examples of the variety of form that has been imposed on the basic "frog" plan.

The differences between a "frog" and a "toad" are frequently subjective. The term "frog" should, by rights, apply only to the frogs on the genus *Rana* while "toad" should, strictly speaking, be reserved for toads of the genus *Bufo*. These are the genera that occur in Europe and were originally granted these names. But only a minority of the world's frogs and toads belong to these two genera. The rest of are assigned one name or the other largely depending on whether they appear to be more frog-like or toad-like. Thus, there are Spadefoot Toads, Chorus Frogs, Narrow-mouthed Toads, Clawed Frogs, Fire-bellied Toads and Poison-dart Frogs, none of which is particularly closely related to ranid frogs, bufonid toads or to each other. No wonder scientists use just their Latin names.

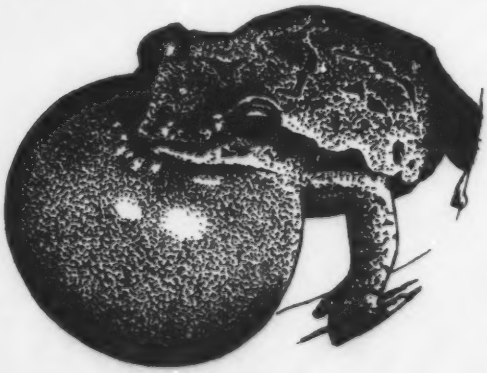
Basically, a "frog", in the broad sense, is adapted for living in the water. It has a smooth skin and a streamlined shape that enables it to move through the water easily. Its long hind legs have fully webbed feet and are designed for swimming. "Toads", on the other hand, are adapted for life away from water. A toad has a tougher, warty skin that helps prevent excess water loss from evaporation, a squat body and short legs that enable hopping or crawling over land. Frogs are better swimmers than toads but toads are better burrowers than frogs. These are the general definitions of "frog" and "toad" but among the members of the order Anura there are treefrogs that have legs adapted for leaping through bushes and trees, "frogs" that are more aquatic than *Rana* and never leave the water and "toads" that are more terrestrial than *Bufo* and never need to visit a pond or stream.

Voice and Social Behaviour in Frogs

Vocalizations play important roles in the lives of all frogs and toads. Only a few primitive species, like the Tailed Frog, lack voices. Many

types of calls, with different meanings, are produced by frogs and toads. These include mating calls (more properly called assembly or advertisement calls), territorial calls, warning calls, fright calls or screams and "rain songs". Not all species have this entire repertoire but some single calls may have double meanings. Frog calls are almost always the exclusive priority of the males; few female frogs have voices.

In the spring, the voices of frogs fill the night air. Species that breed explosively, congregating in small areas for short periods of time, such as Spadefoot Toad, tend to have assembly calls. Male Great Basin Spadefoot Toads will set up a raucous din at their breeding site which enables other spadefoots to find the site and find each other. Most species of toads, genus *Bufo*, also broadcast assembly calls from their breeding ponds, but, oddly, the Western Toad does not have such a mating call. Male Western Toads do, however, have a well-developed warning or sex-recognition chirp. When male toads are in breeding spirit, they may be aggressive and attempt to grab just about anything that looks remotely like a conspecific female, including other males. To recognize who's who, the males of most species have a distinctive call or chirp to identify their sex. Often this call is accompanied by a vigorous bodily vibration. So, when a male toad grabs another male toad, he gets an argument which enables him to recognize his mistake. A gravid female will not protest.



Spring Peeper calling

Hylid frogs, like the Northern Chorus Frog and the Pacific Treefrog, have a different mating system from the toads and spadefoot toads. Their mating calls are both advertisement calls, directed towards females, as well as territorial calls, directed towards other males. Unlike toads, male treefrogs tend to sit in one place to call and use the calls of their neighbours to space themselves apart. The female treefrogs home in on these calls to find their mates.

In may ranid frogs, the males may set up territories in their breeding ponds which they actively defend by calling, by using threatening displays or by wrestling with intruders. The bright yellow throats of male Green Frogs and Bullfrogs are used as threat gestures towards rivals. These are aquatic frogs with extended breeding periods. The females share the pond with the males for most of the year so there is not much need for an assembly call. Any female within a calling male's territory is fair game for that male. Green Frogs will increase the intensity and frequency of the territorial call if a rival male is calling too close by. Male Northern Leopard Frogs have a variety of strange noises that they will utter if they feel their territorial integrity is being threatened by another male.

Each species of frog has its own distinctive assembly and territorial calls or songs. The songs, therefore, are good ways to identify species. In one instance, the two almost identical species of Grey Treefrogs of eastern North America can only be told apart in the wild by their distinctive mating calls.

The songs of male frogs are produced by the passage of air rapidly back and forth over the vocal chords between the lungs and the buccal cavity. The mouth and the nostrils are kept closed while the frog is calling. This enables a frog to sing under water, as does the Red-legged Frog. Most species of frogs have expandable vocal sacs that act like resonators to increase the volume of the sound. One median or two lateral sacs may be present, internally or externally, depending of the species. The effect of a vocal sac on the sound is similar to the effect achieved by the hollow body of an acoustic stringed instrument like a guitar. The plucked guitar string is, by itself, very quiet but, coupled to the resonating air inside the guitar body, the sound is greatly amplified. A chorus of 25-millimetre-long Pacific Treefrogs can be heard more than a kilometre away because of the amplifying qualities of each frog's vocal sac.

Frogs calling in a chorus do not call at random times. They take turns. Some species, like the Pacific Treefrogs, form impromptu duets. Each frog places its call between those of its neighbour. The eastern Spring Peeper, *Hyla crucifer,* forms trios.

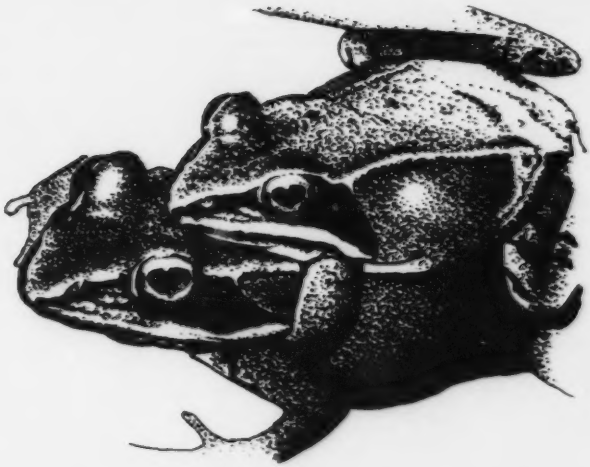
Frequently, in mid-summer or fall, a treefrog can be heard singing, half-heartedly, some distance from the water or from up in a tree. This call is known as a "rain song". It is usually associated with a rise in humidity. The song may have some territorial significance. Sometimes a frog may be induced to sing in this way by some loud noise nearby.

Many ranid frogs will emit alarm or fright calls. Bullfrogs and Green Frogs will scream and wail when they are frightened as they leap into the water or if they are captured. This is one of the few kinds of calls that is not restricted to males. Females and juveniles may also give this call.

Most frogs are solitary for most of the year, although some of the more aquatic frogs may maintain territories through most of their active season. No species of frog or toad in British Columbia exhibits any parental care. Among many tropical frogs, though, many instances of territorial systems and parental care for eggs or tadpoles are known. The tadpoles of the Western Toad show a sort of social interaction by forming schools, which consist mainly of siblings. Once they transform into toadlets they go their separate ways.

Breeding in Frogs

Whatever social structure or calls they may have, the frogs and toads of British Columbia, with one exception, employ a familiar breeding method and life history. When mating, the male clasps the female with his forearms. This is called "amplexus". Amplexus may be in one of two places. In pectoral or axillary amplexus, the male clasps the female behind the arms; in pelvic or inguinal amplexus, he grasps his mate around the waist. Most species in British Columbia have pectoral amplexus but the Tailed Frog and the Great Basin Spadefoot Toad have pelvic amplexus. The eggs usually are laid in standing water and they are fertilized externally as they are laid. The exception to this is the Tailed Frog, which employs internal fertilization and lays its eggs in flowing streams.



Wood Frog in amplexus

The eggs of frogs, like the eggs of all amphibians, are surrounded by transparent jelly coats. This makes the development of the egg inside easy to watch as it proceeds from a single cell to a tadpole ready to hatch. The newly emerged tadpole is helpless. Initially, it has non-functional eyes, no legs and a closed-off mouth. It has external gills and an incompletely developed tail. All the newly hatched tadpole can do is stick to its egg mass with suckers located under its head. Shortly, though, its eyes, mouth and tail develop and it can swim off. A flap of skin on each side of the head grows back over the gills to cover them. Thereafter the water that flows over the gills is taken in through the mouth and is expelled through a single spiracle that is usually located on the left side of the body.

Legs develop as the tadpole grows. The front legs develop first but their growth is hidden by the skin that covers the gills. Consequently, the developing hind legs are the first to be noticeable. When the tadpole transforms into a little frog, the front legs pop out from under their flaps of skin, the left leg emerging through the spiracle.

Eggs of the Western Toad

Eggs of the Wood Frog

Although all the frogs and toads in British Columbia go through this "typical" life history, elsewhere, especially in tropical regions, frogs have a great variety of life history strategies. The South American treefrog, *Hyla boans*, builds a mud nest; *Phyllomedusa* treefrogs lay their eggs in rolled up leaves; and many leptodactylid frogs build nests of foam. The male Midwife Toad of Europe carries its eggs wrapped around its loins. The Surinam Toad, *Pipa pipa*, incubates its eggs in the skin of the mother's back. Darwin's Frog, *Rhinoderma darwini*, of Chile broods its eggs in its vocal sacs while, strangest of all, the Australian *Rheobatrachus* broods its eggs and tadpoles in its stomach. Although the Western Toad, for example, may lay many thousands of eggs in a single breeding season, some frogs, like the many species of *Eleutherodactylus* from Central and South America and the West Indies, will lay fewer than a dozen eggs in a clutch which develop directly into tiny frogs. There are even some frogs of the genus *Nectophryoides* from west Africa that give birth to fully metamorphosed young.

Characteristics of frogs

Artificial Key to Living Adult Frogs and Toads of British Columbia

1a. Pupil of eye vertical when contracted 2

1b. Pupil of eye horizontal when contracted 3

2a. Sharp-edged, horny spade on underside of foot, body squat and toad-like ..... *Great Basin Spadefoot Toad* ***(Scaphiopus intermontanus)***

2b. No spade on sole of foot, male with tail-like copulatory organ ..... *Tailed Frog* ***(Ascaphus truei)***

3a. Parotoid glands and rough warts present, body squat ..... *Western Toad* ***(Bufo boreas)***

3b. No parotoid glands or warts present, skin smooth or with scattered tubercles 4

4a. Conspicuous adhesive toe-pads present, dark eye stripe ending at shoulder ..... *Pacific Treefrog* ***(Hyla regilla)***

4b. Toe-pads absent or inconspicuous 5

5a. Body elongate with dark side stripes extending to groin three dorsal stripes or series of spots also present ..... *Northern Chorus Frog* ***(Pseudacris triseriata)***

5b. Dark side and dorsal stripes absent, dorsolateral folds and/or skin fold around ear membrane present 6

6a. Large rounded spots with light halos present on a green or brown background, belly white, dorsolateral folds present ..... *Northern Leopard Frog* ***(Rana pipiens)***

6b. No large, rounded spots on back 7

7a. Colour green or olive green, no dark facial mask present. Adult males with deep yellow throats and ear membranes larger than diameter of eye 8

7b. Colour brown or tan, may have black, irregular spots on back, dark facial mask more or less obvious 9

8a. Dorsolateral folds present ..... *Green Frog* ***(Rana clamitans)***

Artificial Key to Living Adult Frogs and Toads—continued

8b. Dorsolateral folds absent, skin fold around ear membrane present ..... *Bullfrog* ***(Rana catesbeiana)***

9a. Distinct, black facial mask present, no black dorsal spots, white belly, white mid-dorsal stripe may be present ..... *Wood Frog* ***(Rana sylvatica)***

9b. Red, orange or yellow colouration underneath especially in older individuals, dark spots present on back, facial mask present but not intensely dark 10

10a. Eye upturned, salmon colour on white background on belly and under legs, distinct dark spots on back, no green area in groin ..... *Spotted Frog* ***(Rana pretiosa)***

10b. Eye not upturned, yellow or red underneath 11

11a. Red-coloured underparts, bones of lower leg may be visible through skin, area of green in groin ..... *Red-legged Frog* ***(Rana aurora)***

11b. Yellow or cream underparts, intense black spots on back ..... *Cascades Frog* ***(Rana cascadae)***

FAMILY ASCAPHIDAE—TAILED FROG

Tailed Frog ***Ascaphus truei*** Stejneger
(Tailed Toad, Bell Toad)

Tailed frogs are unlike any other North American frog and combine many of the most primitive features to be found among living frogs. While frogs and toads as a group characteristically have no ribs and no tails when adult, the adult Tailed Frog has both free ribs and tail-wagging muscles, as well as other primitive features. The tail-wagging muscles have nothing to do with the male's false "tail". The only living frogs that approach the Tailed Frog in primitiveness are those in the genus *Leiopelma* of New Zealand and the two genera may not be closely related.

Tailed Frog

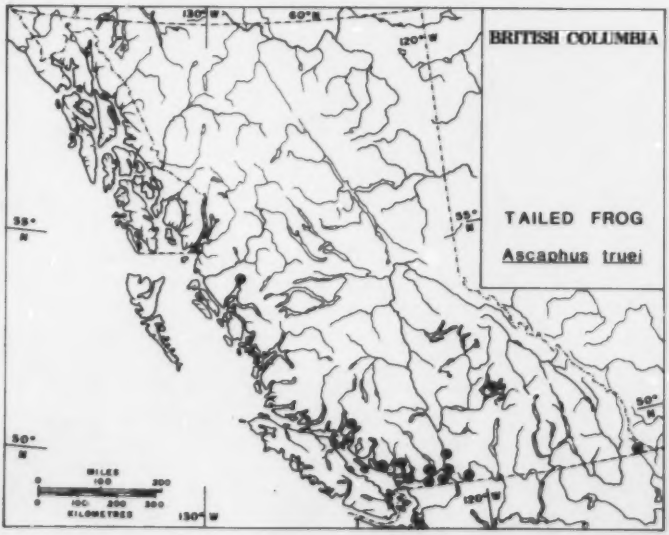
Distinguishing Features—The Tailed Frog has vertical pupils and does not have any spades or horny tubercles on the soles of the feet. No ear membrane is visible. Males have an unmistakeable tail-like extension of the cloaca.

Description—This is a delicate-looking frog that is usually brown or grey although some may be rather pinkish or even black. There is a light patch between the eyes that extends forward across the snout but there are no spots or blotches on the back. The belly is usually translucent pink. Small white dots are scattered over the belly and sides. The head is wide and the nostrils are placed far apart. The eyes have vertical, diamond-shaped pupils. A slight fold of skin curves back from the eye to the corner of the mouth. No tympanum, or ear membrane, is visible. There are no dorsolateral folds or glandular warts on the body, although there may be small tubercles. The toes of the hind feet are short but the feet are fully webbed. The outermost toe of the hind foot is thicker than the rest of the toes. Males are 30 to 40 mm long. They have a fleshy grey "tail", which is actually an extension of the cloaca and not a true tail. In the breeding season, males develop black pads on the hands and black tubercles on their arms and sides. Females are larger than the males and may reach 50 mm in length.

The tadpoles of the Tailed Frog are unique in North America. They are slate grey, up to 30 mm long, and have a white spot on the tip of the tail. Under the head are large, suctorial mouthparts. Within the mouth disc are broad, horny upper jaws and large numbers of labial teeth.

Habits—The Tailed Frog is an inhabitant of mountain streams in undisturbed forest. They require cold, clear, unsilted waters. During the day, they are most often found under stones or rocks by the stream or creek edge or in little rivulets nearby but they will wander off into the forest on rainy days. They are most active at night. They have small lungs and probably rely on their vascularized skins for much of their respiration. Such reduced lungs do not present a problem to frogs that live in fast, well-oxygenated streams.

The Tailed Frog's tongue is attached to the back of the mouth, rather than in the front as in most frogs and toads; therefore, it cannot be flipped out to catch insects. Tailed Frogs eat terrestrial and aquatic insects, and apparently also forage underwater.



Tadpoles of the Tailed Frog

Breeding—Tailed Frogs breed in the fall. They do not appear to vocalize in any way. The male clasps the female around the waist in pelvic amplexus and uses his "tail" for insemination. The sperm remain viable with the female's oviduct until egg-laying many months later. The male's vent is at the tip of the "tail". This is one of only a few frogs in the world that practise internal fertilization.

In mid-summer the female lays clear, unpigmented eggs in small clumps under stones in the stream. The tadpoles can cling with great force to the rocks in the stream and they are able to negotiate the swiftest currents. They hunch their way over rocks using their sucking mouthparts, scraping off algae and diatoms as they go. They move about mostly in this manner but they will swim for short bursts. They can often be seen clambering over exposed rocks in mid-stream. The tadpoles may take two or possibly three years before transforming in late summer and they may not reach maturity for seven years.

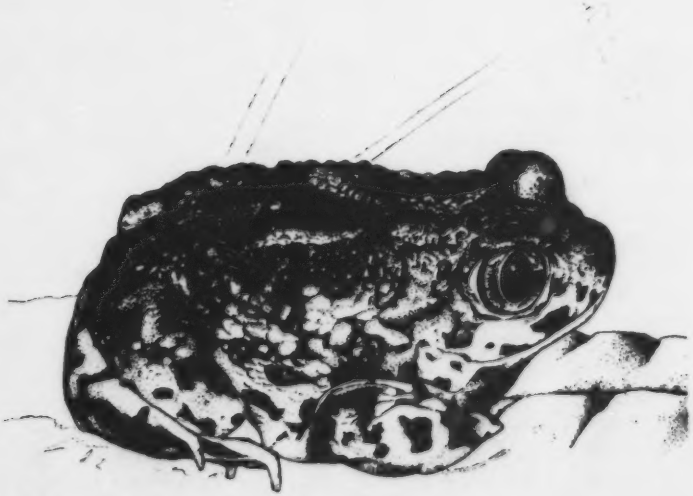
Range—The Tailed Frog has two disconnected parts to its range. It is found along the Pacific Coast of British Columbia and as far south as northern California. Its other range is just west of the Rocky Mountains in Idaho and Montana, just barely extending into British Columbia.

In British Columbia, it is found in the hills and mountains of the south coastal mainland and around the Fraser Valley, as well as in the southeast near the Flathead River. It has recently been found on the north coast near Kitimat and may in fact occur along the whole coastal mainland of British Columbia.

FAMILY PELOBATIDAE—SPADEFOOT TOADS

Great Basin Spadefoot Toad ***Scaphiopus intermontanus*** (Cope)
(Western Spadefoot Toad)

Spadefoot toads are adapted for life in desert or semi-desert regions. They escape from drying conditions mainly by burrowing. On the sole of each hind foot is a single enlarged tubercle or "spade" which enables them to burrow efficiently. Many species of Spadefoot Toads breed explosively in the most temporary of pools after heavy rains. In some species the tadpoles are known to become carnivorous and develop larger mouths and other distinctive morphological features.



Great Basin Spadefoot Toad

Distinguishing Features—The Great Basin Spadefoot Toad has a squat body with tubercles but it has no warts or parotoid glands. It has vertical pupils and a single, horny spade on each hind foot.

Description—Great Basin Spadefoot Toads are ordinarily grey or olive grey with two indistinct and irregular light bands bordering the back. There may be small tubercles or reddish spots present. The belly is dirty white, without markings. A raised, glandular lump or "boss" is present between the eyes. The distinctive, brassy, "cat" eyes have verticle, lens-shaped pupils. The tympanum is indistinct. The legs are short and the hind feet are partially webbed. The single, black "spade" on the sole of each hind foot is prominent. They may be 40 to 60 mm long. Males have dark throats and develop black pads on their thumbs at breeding time. The females are slightly larger than the males.

The tadpoles of the Great Basin Spadefoot Toad are large and have close-set, raised eyes, high tail fins and globular bodies. They are irridescent steel grey and may reach 65 to 70 mm in length. Carnivorous tadpoles with enlarged heads and jaws, such as may occur in other species of Spadefoot Toads under crowded conditions, have not yet been reported in the Great Basin Spadefoot Toad.

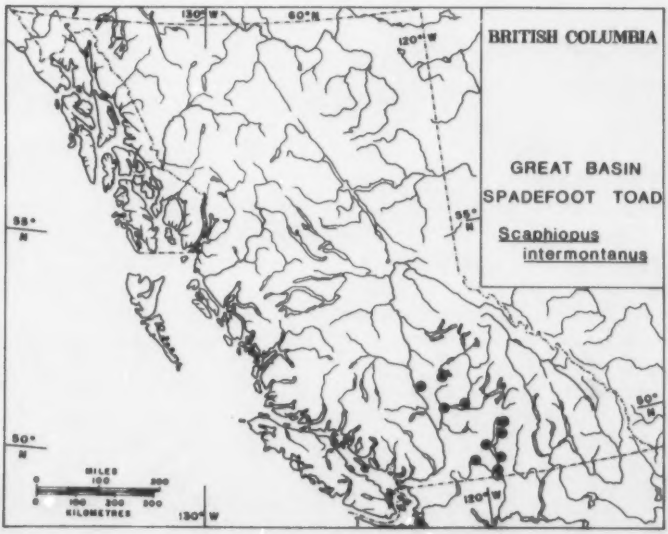
Habits—This is an inhabitant of open woodland, meadow, sage or bunch grass prairie. It is unable to live in extremely dry, true desert. It is often found near lakes or permanent ponds in the dry interior valleys of the province but it will range far afield to higher elevations. It prefers sandy soils. It is principally nocturnal and may actually be quite abundant in some areas even though not often seen. It will be abroad on summer nights, especially if there is rain. During the day, and particularly dry weather, a Spadefoot Toad will burrow into the soil and remain dormant, sometimes for long periods. It burrows backwards using the spades on its hind feet to push the soil aside. Deep within its burrow, its absorptive skin allows a Spadefoot Toad to extract moisture from the soil around it. Spadefoot Toads also use their excellent digging abilities to escape from predators by disappearing rapidly into the soil. The skin poisons of the Great Basin Spadefoot Toad are potent and bad tasting.

Breeding—The Great Basin Spadefoot Toad will breed in temporary pools or the shallows of lakes in the early summer. Generally, they will

wait for a rain before breeding. Breeding activity in any one locality usually takes no longer than a week. The male's call is a rapid, insistent *gwa gwa gwa gwa*. They usually call in large choruses. A large, somewhat bilobed vocal sac distends beneath the chin when the male is calling. The male grasps the female around the waist in pelvic amplexus.

The black eggs are laid in clumps in shallow water. Growing rapidly, the tadpoles feed voraciously on anything organic they encounter, including algae, aquatic plants, dead fish or other tadpoles and even their own feces. The tadpoles transform in about six weeks. The toadlets are 20 to 25 mm long and reach sexual maturity in two to three years.

Range—Inhabits the intermontane region between the Rocky Mountains and the coastal ranges from northern Arizona to southern British Columbia. In British Columbia, it is found in the Okanagan and Nicola valleys of the dry interior as far north as 70 Mile House in the Cariboo region.



FAMILY BUFONIDAE—TOADS

Western Toad ***Bufo boreas*** Baird and Girard
(Boreal Toad, Northwestern Toad)

Toads are chunky amphibians adapted for life on land. They tend to have thicker skins and shorter legs than typical frogs. Horny tubercles on the hind feet enable toads to dig backwards into the ground to hide or to escape dryness. Their characteristic warts are poison glands that secrete a foul-tasting fluid that deters predators.

Distinguishing Features—The Western Toad has conspicuous parotoid glands at the back of the head and reddish warts all over the back and legs. The pupils are horizontal.

Description—Western Toads are quite variable in colour. They may be predominantly green, brown or black dappled in diffuse light and dark patches. A more-or-less well-defined white stripe may run down the middle of the back. The belly is white, mottled with black spots or blobs. There is a grey "pelvic patch" of thin skin under the groin area that looks somewhat like a pair of dotted underpants. The gold-flecked eyes have horizontal pupils. A large, kidney-shaped parotoid gland is located behind each eye. The ear membrane is small. The rough skin of the body and legs is covered with round, reddish warts. A large wart is located on each calf. The legs are moderately short. Two enlarged, horny tubercles are present on the sole of each hind foot. The hind feet are partially webbed. Males have longer arms and narrower heads than females. They also have smoother skins in the breeding season. Both sexes have light-coloured throats. Males in breeding condition develop black pads on their thumbs. Males will chirp their release call, throughout the year, if they are grasped around the body or under the arms. Females are silent. Males can be from 60 to 110 mm long; females, up to 125 mm long.

The tadpoles are small and black. Their eyes are close set on top of the head. The tail fin is rounded and is confined to the tail. They are about 25 to 30 mm in length.

Habits—Western Toads can be found in fields, forests or meadows. They will roam quite far from standing water but prefer damp conditions and cannot tolerate extreme dryness. During dry periods in summer, they

Western Toad

look for a depression in the ground and wait until conditions are more suitable. Their warty skin is moderately resistant to dessication while the thin skin of the "pelvic patch" enables them to absorb moisture from the ground. They are most active at night and are most often seen in the evening when they emerge from their hiding places to forage. Their food consists of worms, slugs or insects but they may eat larger items if given a chance. Western Toads do not seem to occur in heavily urbanized areas but they do well in rural farming districts where they help remove large numbers of unwanted insects.

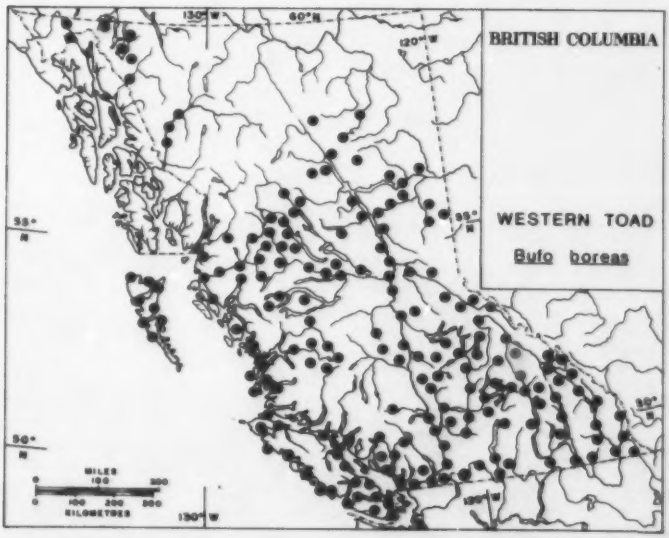
Few animals other than some snakes will eat an adult toad. When frightened, a Western Toad will at first try to hop away. If that fails, it will rear up on all fours, puff itself up and tuck its head down. This defensive position presents the poison-containing parotoid glands and warts to the attacker. The poison is purely for defense. The toad will not attack or try to bite. Toads have no teeth, anyway. A severely agitated or injured toad can voluntarily exude the white poison from its skin glands. The poison is acrid and bitter and causes a burning sensation or numbness when in contact with another animal's mouth or lips. The major predators of Western Toads in British Columbia are garter snakes, which can tolerate this poison. If all else fails, though, the toad will urinate on its captor.

Breeding—In the spring, Western Toads congregate in small ponds or pools to breed. They prefer shallow water with a sandy bottom. They will breed even in temporary pools beside lakes or rivers. Male toads in British Columbia have no mating call, although a mating call has been reported from breeding Western Toads in Alberta. Without such an advertisement call, males search the breeding pond, during the day and night, for prospective mates. With their strong arms, they will clasp anything that resembles a female toad, including large sticks, or bewildered frogs. There is no apparent territorial behaviour. Males can recognize when they've grasped another male by the vigourous chirping release call given by the offended captive. Gravid females do not chirp or protest when clasped. Amplexus is pectoral.

Western Toads in amplexus

The eggs are laid in long strings which are usually found entwined among submerged vegetation. A single female can produce more than 12,000 eggs in a clutch. The tadpoles develop rapidly and transform into 10-mm long toadlets in about six to eight weeks, depending on the temperature. The tadpoles form tight feeding clumps or synchronized schools as they swim. In mid-summer, large aggregations of transforming tadpoles and toadlets gather around the banks of the breeding pond where they fall easy prey to garter snakes and birds. Juvenile toads in late summer frequently have bright yellow foot tubercles. Western Toads reach maturity in two to three years.

Range—Found west of the Rocky Mountains from southern California and east of the Rockies in central Alberta. In British Columbia, it is found throughout the province except for the far northeast. It is the only amphibian native to the Queen Charlotte Islands.

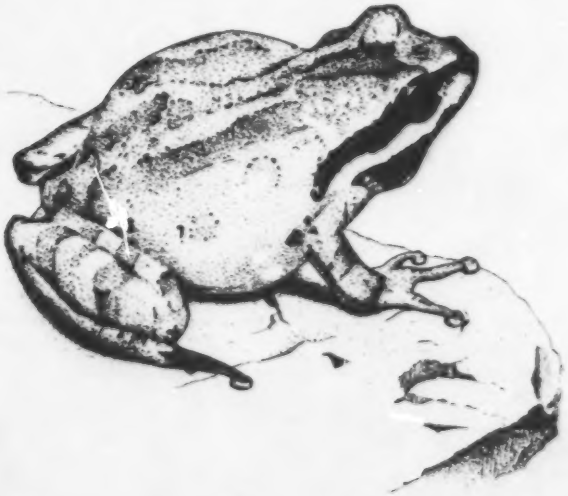


FAMILY HYLIDAE—TREEFROGS

Pacific Treefrog ***Hyla regilla*** Baird and Girard
(Pacific Tree-toad)

Treefrogs are agile, long-legged frogs that have sticky pads on the tips of their fingers and toes which enable them to clamber about in trees and shrubs. They can even cling to walls or windows. An extra, intercalary bone or cartilage is present between the last two bones of each digit to give the pad greater flexibility.

Distinguishing Features—The Pacific Treefrog is the only amphibian in British Columbia with prominent adhesive toe-pads. A treefrog can change its colour but the dark eye stripe extending from the nose to the shoulder is always present. The stripe does not extend to the groin.



Pacific Treefrog

Description—The colour of an individual Pacific Treefrog can be extremely variable. They can also rapidly change their colour; therefore, the same individual may vary between bright green and deep olive-brown or be almost any shade of green or brown in between. A pattern of dark spots, usually including a dark "V" or "Y", between the eyes, is almost invariably present but this pattern will fade when the frog is lightly coloured or will be obscured when the frog is very dark. A dark eye stripe extending from the nose, through the eye, across the tympanum and ending over the shoulder is always present and obvious. An occasional individual may sometimes be found that is bright bronze or reddish on the back. The belly is white or pinkish and unmarked. The skin of the back is smooth. There are no warts or skin folds, but the skin of the belly is granular in appearance. A fold of skin crosses the breast between the front legs, The pupils are horizontal. The legs are long and skinny. Small webs are present between the toes of the hind feet. Each digit of both the front and back feet has a round, sticky toe-pad on the tip. Males have dark, olive throats, Males can be 25 to 40 mm long; females, up to 50 mm.

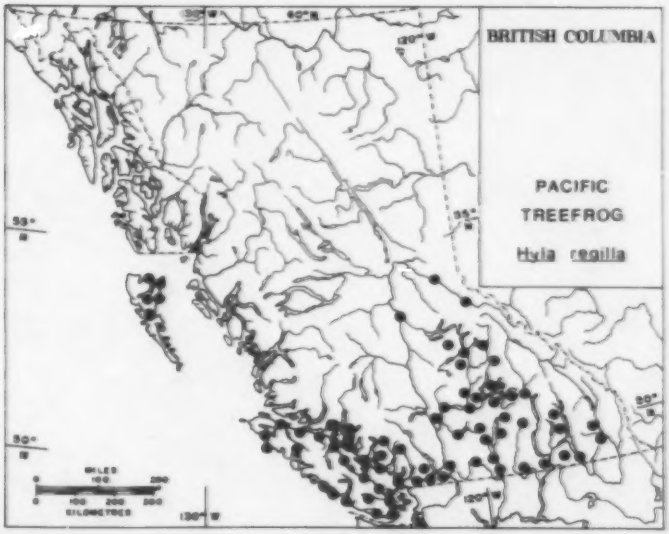
The tadpoles are light greenish grey, up to 45 mm long, and have high tail fins and widely spaced eyes. The internal viscera can be seen through the skin of the belly.

Habits—The Pacific Treefrog can climb trees or bushes, using its adhesive toe-pads. These round discs on the tips of the toes have a specialized, thickened epidermis which sticks to a variety of surfaces by taking advantage of minute irregularities and surface tension. They are agile and adept climbers and can sometimes be found high above the ground although for the most part they forage in low bushes or shrubs. They will sometimes sun themselves on exposed leaves. During the summer they may venture some distance from standing water. Sometimes, on a humid or rainy summer day, a Treefrog may announce its presence with a "rain song" is a shortened, single note version of the mating call, from a tree or bush. They generally inhabit open woods or forest margins, avoid extreme dryness, and are tolerant of farming and suburban areas.

A Pacific Treefrog can change its colour by expanding or contracting the pigment cells of its skin. The colour changes are related to the surrounding temperature and humidity rather than to the actual colour of the place where the frog is sitting. Thus, on a warm dry day the treefrog

will usually turn a light green and so will usually match the colour of the warm, dry leaf it is sitting on. Conversely, a cold, damp treefrog will turn dark. Pacific Treefrogs will eat a variety of crawling and flying insects.

Breeding—They breed in shallow, weedy, permanent ponds and swamps. The male's mating call is a two-note *kreck-ek!* repeated continuously. Amplified by the large, round vocal sac inflated beneath the chin, the call is astonishingly loud for so small an animal. A large chorus of treefrogs in the spring can be heard for several kilometres and will drown out the vocal attempts of other frogs and toads. The male treefrog selects a calling site near the water and will sing from there to attract a mate. The female must approach and sometimes actually touch the calling male before he will react to her presence and attempt to clasp her. His call switches to a single note when another frog is near. Amplexus is pectoral. The mating calls also act as territorial signals and serve to space apart the calling males.



The eggs are laid in loose clusters around submerged vegetation. In two to three months the tadpoles transform into tiny treefrogs about 15 mm long. These reach maturity in about a year.

Range—Found from Vancouver Island and southern British Columbia to southern Arizona and Baja California. In British Columbia, it is found across the southern third of the province as far north as Quesnel.

Pacific Treefrogs have been introduced into the Queen Charlotte Islands on Graham Island. The son of a long-time resident released a jar of tadpoles that he collected at Como Lake on Vancouver Island. Apparently he "liked to hear them sing."

Northern Chorus Frog ***Pseudacris triseriata*** (Wied)
(Striped Chorus Frog, Boreal Chorus Frog, Swamp Treefrog)

Chorus Frogs are close relatives of the arboreal treefrogs but they have assumed burrowing habits. Although they still have the extra intercalary bone in each digit, characteristic of treefrogs, Chorus Frogs do not have large, sticky toe-pads on the tips of the fingers and toes.

Northern Chorus Frog

Distinguishing Features — The Northern Chorus Frog is a small frog with a long body and disproportionately short legs. There are three irregular or broken stripes down the back, and dark stripes on the sides that extend from the nose to the groin.

Description — They may be grey, olive or tan and have three distinct darker stripes along the back. The mid-dorsal stripe may be broken into smaller patches or spots. On either side of the head and body there is another, even darker stripe, that runs from the nose, through the eye and along the side of the body to groin. A cream stripe runs along the upper jaw. The belly is cream or light tan. While the skin of the back is smooth, the belly skin is distinctly granular in appearance. There are no dorsolateral folds or warts. The snout is somewhat pointed. The body is elongated and there appears to be a distinct neck. The legs are comparatively short. The hind feet have long toes with small webs between them. Toe-pads are not noticeable. Males have dark, greenish-yellow throats and are slightly smaller than the females. Northern Chorus Frogs may be between 20 and 35 mm long.

The tadpoles are small, up to 30 mm in length, and dark. They have widely spaced eyes and a high tail fin that extends along the back.

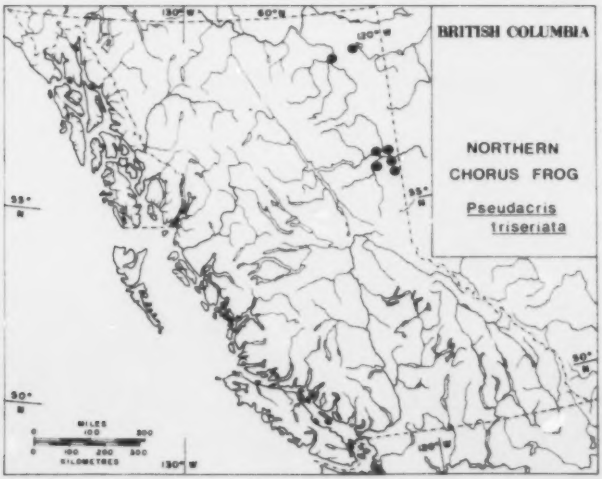
Habits — Northern Chorus Frogs appear to inhabit damp grassy or wooded areas, but they may be largely fossorial in habits and spend most of the summer underground. This may account, in part, for the difficulty in finding them at any time other than during their breeding season. They will appear above ground during the fall, though. Little is known of their habits, especially in northern parts of their range, including British Columbia. In the breeding season, they may be found almost anywhere there is shallow standing water. Where they go after mating is uncertain. They eat ground-dwelling insects and invertebrates.

Breeding — The males will begin to call even before all the snow melts in early spring. They may call from ponds, ditches or melt-water puddles that are still almost entirely ice-covered. In northern British Columbia, they will begin to breed in early May and will continue to call through June. Because they sing so early in spring, Chorus Frogs are sometimes mistakenly known as "Spring Peepers", a name rightly applied to the eastern treefrog, *Hyla crucifer*. Northern Chorus Frogs will call all day in early spring and may sing continuously night and day at the

height of the breeding season. The male's call is a vibrating *krreeeeeep!* that rises steadily in pitch and is repeated every two seconds or so. It sounds like someone stroking the teeth of a stiff plastic comb. The call speeds up in warmer weather and slows down in cold. The male has a large, round, yellowish vocal sac. Chorus frogs usually call while concealed among the mats of dead grass or other vegetation and they can be extremely difficult to see, even while they can be plainly heard. The female locates a male by his singing and is clasped in pectoral amplexus.

The eggs are laid in small clumps, less than 25 mm across, that are attached to submerged plants. The tadpoles develop rapidly and transform in about two months. The little Chorus Frogs reach maturity the following year. It is possible that Northern Chorus Frogs may live for no more than one or two years in the wild.

Range — The subspecies range over North America east of the continental divide from Great Bear Lake in the north to New Mexico and the Gulf of Mexico in the south and to the Atlantic Ocean, excluding southern Florida, most of New England, the Maritimes and most of Quebec. In British Columbia, they are found mainly in the Peace River region.



FAMILY RANIDAE—FROGS

Red-legged Frog ***Rana aurora*** Baird and Girard

The Red-legged Frog, and other frogs of the genus *Rana*, are the "true" or typical frogs. They are adapted for an aquatic or semi-aquatic life and have smooth skins and long legs with fully webbed feet, which are adaptations for swimming. Ranid frogs are found on every continent except Antarctica.

Distinguishing Features — The Reg-legged Frog is a brown frog with a dark mask. The belly and undersides of the legs are bright red. The sides of the groin are blotched with green. The skin of the legs is translucent, allowing the bones of the lower leg to show through.

Description — This handsome frog is a rich brown on the back, covered with many small black spots. The prominent dorsolateral folds which run down each side of the back are a lighter shade of brown. There is a dark mask on the sides of the face above a narrow, cream-coloured jaw stripe on each upper lip. The throat and chest are white, usually flecked

Red-legged Frog

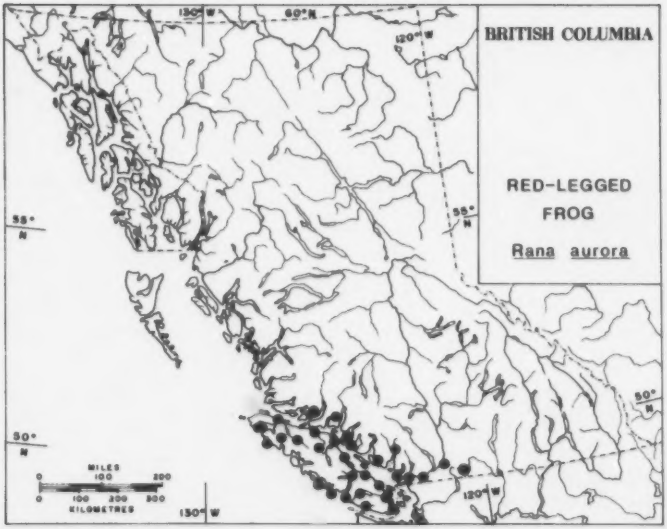
with black. Under the legs and lower belly the flesh and skin is bright red, the latter somewhat translucent. Through it the musculature and bones of the lower leg are plainly visible. The red colour grows more intense with age. Juvenile Reg-legged Frogs may have little or no red while in older individuals the colour may extend onto the sides of the body. On the flanks in the groin area is mottled patch of light green. The arms and legs are darkly barred on the upper surfaces. The snout is rather blunt. The eyes are not markedly upturned. The sexes are difficult to distinguish although males have dark thumbs in the breeding season and are smaller than the females. Male Reg-legged Frogs may be from 50 to 60 mm long; females over 70 mm.

The tadpoles are greenish-brown with numerous light and dark flecks on the back. The belly is white with a pinkish tinge. The eyes are close-set on top of the head. They may reach about 70 mm in length before transforming.

Habits — These are forest-dwelling frogs in British Columbia. While they may be found in larger bodies of water, excepting rocky bottomed lakes, they usually frequent small, quiet pools, swamps or ponds in or beside a sheltering damp forest. They will often wander far from standing water into the forest and sometimes can be encountered during the day along forest trails near damp valley bottoms, but usually they sit on the bank of a small pool in the forest. Their reddish brown colour helps them to blend into the litter of red cedar and hemlock forests. In California, the Red-legged Frog is strictly a pond frog that rarely ventures far from the water. Red-legged Frogs eat small insects and other forest invertebrates.

Breeding—Red-legged Frogs have a short breeding season that starts soon after they emerge from hibernation in mid-February or March. Males call from beneath the water, spacing themselves a few metres apart. The call is a feeble, short stutter described as *uh uh uH UH* lasting a little more than a second. Rarely can it be heard over the noisy choruses of Pacific Treefrogs which often breed at the same time. The vocal sac is internal. It is only noticeable as a swelling of the frog's throat and neck during a call. The male grabs the female pectorally. He repeatedly emits a single, low pitched call note while in amplexus.

The eggs are laid in loose, solitary masses under the water. The tadpoles transform in mid-summer into froglets about 25 mm long. They will mature in two to three years.



Range—Found west of the coastal mountain ranges of western North America from southern British Columbia to northern Baja California. In British Columbia, it occurs on Vancouver Island and adjacent mainland, the Gulf Islands and in the extreme lower mainland along the Strait of Georgia and through the Fraser Valley to Manning Park.

Spotted Frog ***Rana pretiosa*** (Baird and Girard)
(Western Spotted Frog)

The Spotted Frog, Red-legged Frog and Cascades Frog comprise a group of similar species in western North America. All are brown frogs that have some red, orange or yellow on the belly. This may cause some confusion in telling them apart but there are other reliable characteristics that will discern them.

Spotted Frog

Distinguishing Features—In contrast to other similarly brown, spotted frogs, the Spotted Frog has eyes that are decidedly upturned. The salmon colour of the belly and legs appears painted on an opaque white skin. The leg bones are not visible through the skin. There is no green in the groin.

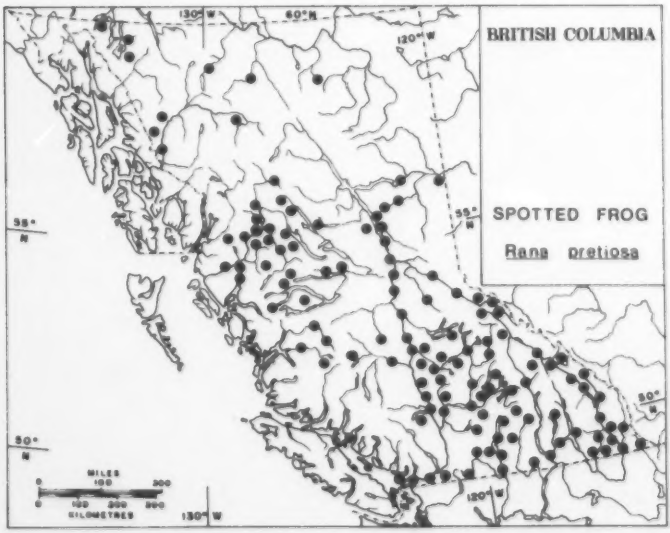
Description—The Spotted Frog may be olive, light brown or tan. Several black spots with light centres are scattered over the back. The sides are mottled with black and may have small reddish tubercles. Sometimes, only the faintest hint of a dark face mask is present. A light tan stripe on the upper jaw reaches to the shoulder. The undersurface is opaque white, painted over with red, salmon or orange pigment on the lower belly and legs. There are no other markings on the belly. The red occasionally spreads over the whole underside and onto the throat. This colour intensifies with age; small froglets may have no colour on the belly. No green is present on the flanks or groin. The eyes point upward, giving the frog rather a dull-witted expression. The snout is pointed. The body is rather robust. Frogs in northern regions may have somewhat shorter legs. The hind feet have large webs. Dorsolateral skin folds are present along each side of the back but they are not always distinct. Males

have enlarged thumbs in the breeding season but otherwise are similar to the females. They may be 50 to 70 mm long; females may reach 90 mm in length.

The tadpoles are similar in shape and colour to the tadpoles of the Red-legged Frog but they are not so heavily spotted. They may reach 60 to 70 mm in length.

Habits—Spotted Frogs are much more aquatic than Red-legged Frogs. They are particularly unwary and sluggish and are easily approached. If frightened, they will usually only swim to the bottom of the pond a few feet away and lay there. Spotted Frogs prefer permanent ponds and small lakes and are tolerant of cold waters. They range far to the north and up to the tree line in elevation. They sometimes forage abroad in meadows or damp woods and may be active during the day.

Breeding—Spotted Frogs breed early in the spring, usually before the ice has fully disappeared from the surface of the breeding ponds. The



males station themselves along the shore and call with their heads just out of the water. Their voices are low in pitch and volume and have little carrying power. Consisting of a series of seven to nine short grunts of increasing intensity, a call typically lasts about a second and a quarter. The males increase the number of grunting notes per call in territorial disputes. The vocal sac is internal. The male clasps the female in pectoral amplexus. The breeding period is quite short and lasts only a couple of weeks. In the far north, like many northward ranging amphibians, the Spotted Frog's breeding activity frequently extends throughout the daylight hours.

The eggs are laid in communal masses at the surface of the water. The tadpoles transform in the summer of the same year but may overwinter as tadpoles farther north. The newly transformed froglets are about 25 mm long and will reach maturity in two to three years.

Range—Found between the Rocky Mountains and the Coast and Cascade ranges from northern British Columbia and the Alaska panhandle to northern California, Nevada and Utah. In British Columbia, they occur over the entire province except the Peace River district, the islands off the Pacific Coast and most of the southwestern coast of the mainland. They do occur around Surrey in the lower Fraser Valley, and have been collected at Vancouver.

Cascades Frog ***Rana cascade*** Slater

The Cascades Frog has never been reported from British Columbia but since its known range in the state of Washington is close to the British Columbia border it is possible that it may occur in this province. Its close resemblance to both the Red-legged Frog and the Spotted Frog, and the relative inaccessibility of its high-altitude habitats, may be why it has not been reported in British Columbia. A brief description of the Cascades Frog is given here.

Distinguishing Features—The Cascades Frog is yellow rather than red or salmon under the waist and thighs. There is no green in the groin. Its eyes are not markedly upturned.

Cascades Frog

Description—Cascades Frogs are brown frogs with dark masks and are similar to Red-legged Frogs. On the back are distinct black spots with light centres. A light stripe extends from the jaw to the shoulder. The undersurface is off-white changing to bright yellow or cream under the waist and legs and may be mottled with dark pigment. The eyes are not upturned as they are in the Spotted Frog. Dorsolateral folds are present and there may be numerous tubercles on the sides. Males may be 50 to 60 mm long; females, slightly larger.

Range—Found at elevations above about 1 000 metres in the Cascade Mountains through Washington, Oregon and northern California. It is known to occur close to the Canada-United States border and may possibly enter British Columbia in the Cascade Mountains between the Skagit and Similkameen rivers.

Northern Leopard Frog ***Rana pipiens*** Schreber
(Meadow Frog, Grass Frog, Leopard Frog)

Until recently, the Leopard Frog was considered to be a single, extremely variable and wide-ranging species. Large numbers of them were, and still are, used in laboratories and schools. It is now certain, though, that what was thought to be the "Leopard Frog" is actually a complex of at least seven different, but related, species in North America. The northern-most of those species occurs naturally in British Columbia.

Distinguishing Features—The Northern Leopard Frog is a slim, medium-sized brown or green frog with large, distinct, solid-coloured spots on the back sides and legs. These prominent spots may be scattered randomly or arrayed in two or three rows down the back and have dark edges accented by light-coloured halos.

Northern Leopard Frog

Description—The colour of the Northern Leopard Frog may be either grass green or light brown overall. The solid, dark brown, or olive, spots on the back have smooth, round edges and are sharply accentuated by dark edges and light outside halos. They can be in two or sometimes three rows down the back and vary both in size and number. Similar dark bars also occur on the legs. The belly is white and unmarked. A white stripe along the upper jaw extends to the shoulder. The dorsolateral folds are prominent and are generally lighter than the background colour of the body. They extend from the head to the groin without a break. There may also be other, less prominent, non-glandular skin ridges along the back. The snout is pointed. The legs are long; the hind feet, fully webbed. The body is slim and the skin is smooth. Males have dark, swollen thumbs in the breeding season. Internally, male Northern Leopard Frogs have vestigial oviducts. This is one of the features that helps to distinguish between the various related species of "Leopard" Frogs. Males may range between 50 and 80 mm in length; females are slightly larger.

The tadpoles are brown with fine light spots. The skin of the belly is translucent so that the internal organs can be seen. They reach about 75 mm in length.

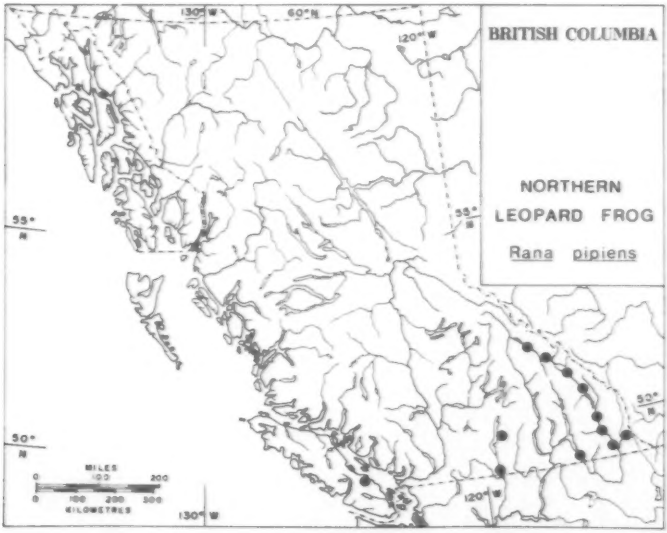
Habits—The Northern Leopard Frog is a highly adaptable species found in many habitats. It is tolerant of cold climates and will often venture far from standing water through grassy fields or meadows, especially on damp days in summer or fall. They may be abundant in some areas and can be major food sources for snakes, raccoons, shrikes and other predators. Besides leaping away and hiding under the mud of the pond bottom, their only apparent defensive behaviour is to give a squealing distress call if seized. Northern Leopard Frogs, in their turn, prey on insects, spiders and other small invertebrates.

They hibernate *on* the bottoms of lakes or streams during the winter, that is on the sand or mud, in shallow depressions, rather than burrowing into it. A warm spell in mid-winter will sometimes result in the occasional untimely emergence of a frog from its hibernation.

Breeding—Northern Leopard Frogs breed almost as early in the spring as Northern Chorus Frogs and Wood Frogs. They often do not wait for the ice on the ponds to melt fully. They migrate from their hibernation sites to suitable open, small, well-vegetated breeding ponds and swamps.

Males will gather in selected, localized areas and will call while they float on or just beneath the water's surface. Round, paired, vocal sacs balloon out from the sides of the throat during a call. The dominant vocalization is a long, low, guttural rumble which can be described as something like *ira-ah-ah-ah-ah-ah-ah-ah* . . . and sounds reminiscent of a small, puttering motorboat. This call acts as an assembly and territorial spacing call. They also have a large repertoire of grunts, hoots, groans, snores and pops that may may be associated with territorial disputes. Males will aggressively search for receptive females and will grasp them in pectoral amplexus.

The round or oval egg masses are laid either attached to submerged sticks and dead vegetation or sitting freely on the pond bottom. Usually many of the egg masses of a particular breeding congregation will be laid close to each other. The tadpoles transform in mid-summer into 25-mm-long froglets. At first, the newly transformed froglets may be without the large spots of the adults. They take two or three years to reach maturity.



Range—The various, allied species of Leopard Frogs cover, between them, most of North America and Mexico excluding the extreme north and west. The Northern Leopard Frog ranges from eastern British Columbia, Washington, Oregon and California across Canada and the northern United States to New England and the Maritimes, occurring as far north as Labrador, Hudson Bay and Great Slave Lake. In British Columbia, it is found in the eastern Kootenay region and along the southern border of the province near Creston and Osoyoos. An introduced population is found on Vancouver Island near Coombs.

Wood Frog ***Rana sylvatica*** LeConte
(Northern Wood Frog)

The Wood Frog is more widespread, and found farther north, than any other amphibian in Canada. It is the only North American amphibian to cross the Arctic Circle. Its exceptional tolerance of cold and its accelerated larval development help it to cope with northern climates and short growing seasons.

Distinguishing Features—The Wood Frog is a small, brown or grey frog with a distinct black mask, and white underparts. There may be dark markings on the back and a bold white mid-dorsal stripe.

Description—Wood Frogs may be light tan, grey or deep brown. There is always a black mask that covers the tympanum and contrasts sharply with a white stripe along the upper jaw. They may be uniformly-coloured above or have dark spots or mottling on the back and sides. A narrow, bright white stripe running down the middle of the back from the snout to the vent may or may not be present. This stripe is either obvious or entirely absent in any particular individual. Its frequency of occurrence varies among members of different populations. The belly is white with dark flecks at the sides and on the throat occasionally extending onto the chest. The skin is smooth but there may be scattered brown tubercles on the sides. Glandular dorsolateral folds run down the sides of the back. The legs are barred with dark pigment and maybe quite short, especially towards the north. Males and females are similar in appearance. Wood Frogs may be 35 to 50 mm long; females are usually slightly larger than males.

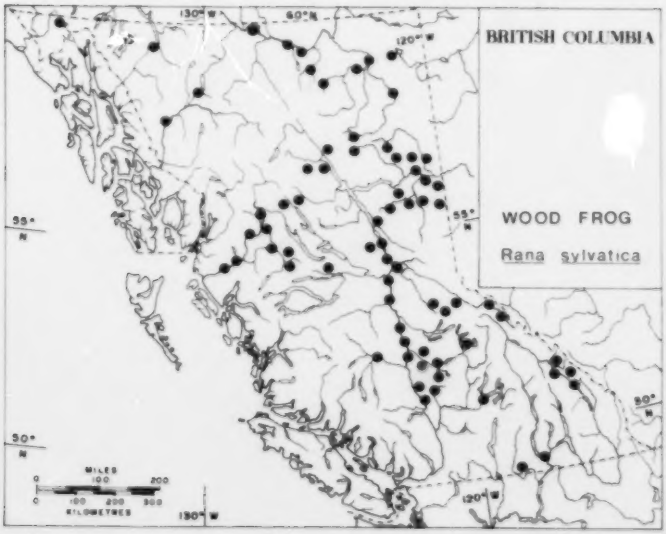
Wood Frog

The tadpoles are grey or black. They are deep bodied with high tail fins that extend well forward onto the back. Their eyes are placed on top of their heads and are widely spaced. There may be a bronze iridescence on the sides. They may be up to 50 mm long.

Habits—The Wood Frog can be found in forest, field or muskeg though usually not too far from water. In the far north, it will even venture out onto the open tundra. It is a highly adaptable amphibian in northern climates and can tolerate cold temperatures. It escapes sub-freezing surface temperatures in winter by hibernating on land underneath the forest litter and humus. It relies on the insulating powers of snow to keep the deep layers of the soil from freezing. The permafrost of the arctic limits its northward range, although some are known to hibernate just above the permafrost layer in northern Alaska and the Yukon. The Wood Frog may be actively breeding at temperatures just above freezing, far too cold for most other amphibians and reptiles. It is quite terrestrial and will forage far and wide through the forest for insects and invertebrates.

Breeding—Early in the spring, usually well before all the ice on the ponds has melted, Wood Frogs begin their short breeding season. Breeding activity may take a few weeks in more southerly parts of its range or only a few days towards the north. Males congregate in shallow, clear ponds and will call day and night as long as the temperature remains above freezing. They have small, paired vocal sacs, one above each arm. The call is a duck-like quack and is much like the sound made by rubbing a wet rubber balloon. There does not appear to be any territorial behaviour in a breeding congregation of Wood Frogs. Amplexus is pectoral. Once the eggs are laid, the frogs quickly disappear into the surrounding forest.

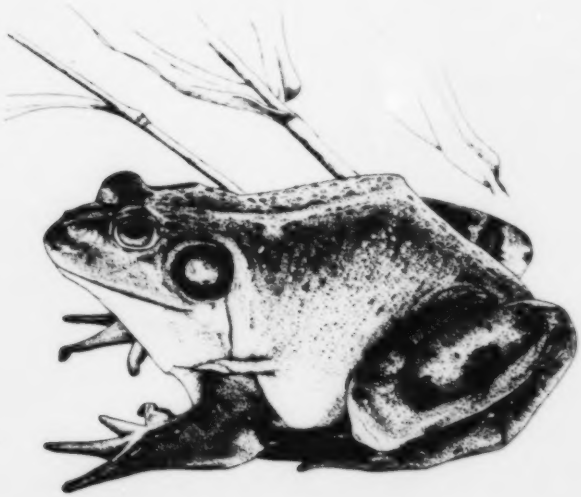
The eggs are laid in globular masses. They may be attached to submerged sticks and plants or lay freely in the water. The tadpoles grow quickly, even at comparatively low temperatures, and are able to transform into little Wood Frogs by mid-summer.



Range—Found across most of Canada and the northeastern United States from the Appalachian Mountains and the Maritimes provinces across Quebec, Ontario and the prairie provinces to include most of the Yukon and Alaska, crossing the Arctic Circle. In British Columbia, it is found over the northern half of the province to the east of the Coast Mountains and extends south through the Cariboo region as far as Clinton.

Bullfrog ***Rana catesbeiana*** Shaw

The Bullfrog is the largest frog in North America. It has been widely introduced outside its native range in eastern North America, usually as stock for largely unsuccessful "frog farms". It now occurs in scattered feral populations in western North America, the Caribbean Islands and even in Hawaii, Japan and Italy.



Distinguishing Features—The Bullfrog is a large, green or olive-brown frog that does not have dorsolateral skin folds along the sides of the back. Instead, a fold of skin on each side of the head runs from the eye around and behind the conspicuous ear membrane.

Description—This large, robust frog may be green, brownish green or olive on the back, often peppered with tiny, black specks or mottled with irregular, diffuse dusky patches. The dusky areas may extend onto the belly. The belly is white but is often mottled with grey and may perhaps have a tinge of yellow under the chin and legs. This colour is not vivid, except under the throats of adult males. There is no light upper jaw stripe nor obvious light moustache. The head is broad and the ear membrane is conspicuous. A conspicuous fold of skin bends around the tympanum from the corner of the eye to the shoulder. There are no dorsolateral folds. The skin of the back may be granular but there are no warts or large tubercles. The sacral hump in the back is usually prominent. Males have bright yellow throats and large ear drums that exceed the eye in diameter. In breeding condition, they have enlarged thumbs. Females have ear membranes that are the same diameter as the eye. Bullfrogs may be 80 to 180 mm in length. Females are larger than males and have been known to attain lengths exceeding 200 mm.

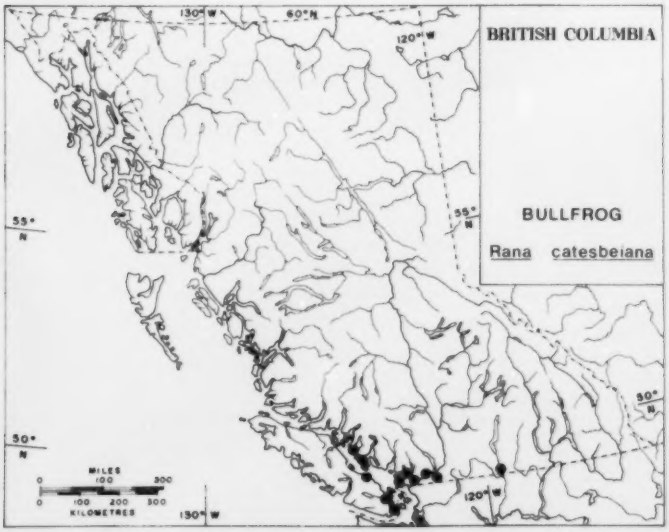
The tadpoles are green with light and dark speckles on their backs and narrow-set eyes on the tops of their heads. They are similar to the tadpoles of Reg-legged and Green Frogs. They can be difficult to distinguish from Green Frog tadpoles especially. When they have grown to near maximum size, though, they are far larger than any other tadpole to be found in British Columbia. They may reach 135 mm in length. They also tend to be more yellowish underneath than other tadpoles.

Habits—Bullfrogs are entirely aquatic and rarely leave the weedy, heavily vegetated permanent ponds and lakes that they prefer. They will also occur, though, in smaller, muddy ponds and ditches. They are extremely wary during the day and will rarely allow anyone to approach more closely than a few metres. When frightened, juveniles sitting on the pond bank will leap helter-skelter into the water, "barking" calls of *nyurp!*, to disappear in the bottom mud. They are much more easily approached at night with the aid of a bright light to dazzle them.

Sometimes they will play dead when caught and then suddenly, and surprisingly, recover.

Although insects are their usual fare when young, adult Bullfrogs are voracious predators and will eat just about anything moving that they can stuff into their prodigious mouths. This includes young birds, mice, fish and smaller Bullfrogs.

Breeding—The Bullfrog has a prolonged breeding season that begins in late spring and extends through the better part of the summer. Adult males are highly territorial and will float, inflated, on the surface of the water while they call and show off their bright yellow throats to rivals. The call is an unmistakable deep bass snore that has been described as *jug o'rum* or *br-wum, bwum, bwum, bwum* or, in French, *auoauaron*. It is very loud and carrying. Calling males attempt to seize any tempting females that venture into their calling territories and sidle up to them while they fend off intruding males with bluffs and wrestling matches.



Often, non-calling males may lie low within a good territory and try to intercept females themselves. Amplexus is pectoral.

The eggs are laid in large, floating masses. The tadpoles spend the next two years, at least, in the pond hibernating in the bottom mud through the winters before they transform. The newly transformed froglets are about 40 mm long and reach maturity in three or four years.

Range—Bullfrogs are native to North America east of the Great Plains from southern Ontario and Quebec to the Gulf of Mexico. They have been introduced in scattered populations throughout western North America and elsewhere. In British Columbia, they occur in the lower Fraser Valley from Vancouver to Chilliwack, on Vancouver Island from Victoria to Parksville, on some of the islands in the Strait of Georgia, near Sechelt, and in the southern Okanagan Valley.

Green Frog ***Rana clamitans*** Latreille

Like the Bullfrog, the Green Frog is an eastern species that is alien to British Columbia. It may have been introduced either as pet stock, fish bait or as stock for frog farms.

Distinguishing Features—The Green Frog is a medium-sized green or olive-green frog with a light green "moustache". Dorsolateral folds are present but extend no more than three-quarters of the way down the back. The back does not have any large, well-defined dark spots and the lower belly is white.

Description—Green Frogs may be greenish-brown or bronze through olive to deep metallic green on the back. They are usually peppered with dark specks or small irregular marks. A bright metallic green "moustache" on the upper jaw is usually present. The belly is white with, on occasion, a few dark spots. Dark bars occur across on the legs. The head is fairly broad and the body robust. The ear membrane is conspicuous. Dorsolateral folds are present but they stop about three-quarters of the way down each side of the back. A fold of skin may circle behind the tympanum. The skin is slightly roughened and there may be wrinkles and tubercles on the sides but no warts. In males, the tympanum is large and

Green Frog

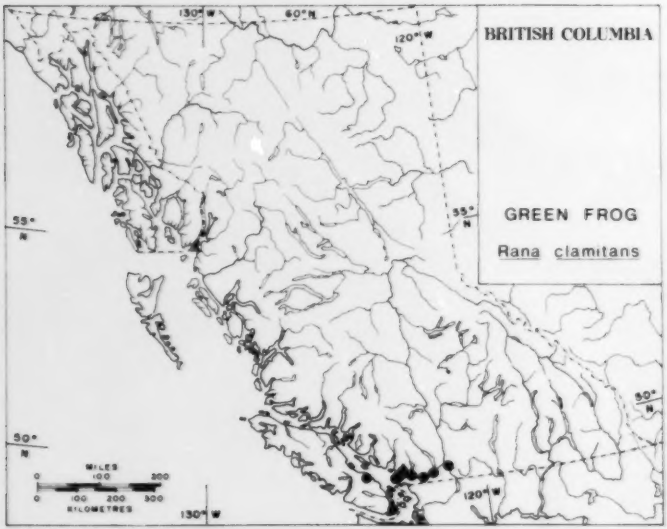
exceeds the eye in diameter. They also have bright yellow throats and, in the breeding season, swollen thumbs. In females the ear membrane is the same size as the eye. Green Frogs may be 50 to 90 mm long. Females are larger than males and may reach 100 mm.

The tadpoles of the Green Frogs are almost identical to those of the Bullfrog except that they do not grow nearly as large. They are rarely more than 90 mm long and have no trace of yellow.

Habits—The Green Frog is typically a pond-dwelling frog. It usually lives in lily ponds and shallow drainage ditches. More terrestrial than the Bullfrog, it will forage through meadows or grassy fields during wet weather. During the day, Green Frogs can usually be found sunning alongside the banks of ditches or ponds. They are wary and often difficult to approach. When frightened, they will squawk and leap frantically into

the water to hide in the mud. Green Frogs consume flying and crawling insects and may also feed underwater.

Breeding—They have a lengthy breeding season that continues throughout the late spring and early summer. Males establish breeding territories around preferred calling and egg-laying sites in the pond. Their basic call is a muffled explosion, *C'tung*, that serves as a territoral warning call. In border skirmishes with neighbouring males, this single note is delivered two or three times in succession. The yellow throat of the male is used as a threat display. Occasionally, males will wrestle each other to determine dominance, accompanied by soft growls and guttural rumbles. A female entering a territory is approached by the resident male who will clasp her in pectoral amplexus. During the the day, males may continue to call from sheltered positions along the shore of the pond. Their vocal sacs are internal.



The eggs are laid in floating masses. The tadpoles winter in the pond and transform the following summer into little frogs about 25 mm long. They mature in two to three years.

Range—The Green Frog is native to eastern North America, east of the Great Plains, from Ontario, Quebec and the Maritimes south to the Gulf of Mexico. In British Columbia, they have been reported from Hope and from near Victoria. They occur in Richmond in the Fraser delta and within Vancouver's city limits in the southwest of the city. They also have been introduced near Coombs on Vancouver Island.

GLOSSARY

Adpress—to press closely against. With salamanders, the relative length of the limbs can be assessed by holding them closely against the side of the body and checking the distance separating them or the amount they overlap.

Aestivate—lie dormant during periods of unfavourable weather.

Amines—nitrogen-containing chemical compounds.

Amplexus—mating embrace of the female by the male.

Buccal—pertaining to the mouth cavity.

Cloaca—common internal receptacle of the excretory, reproductive and digestive systems, opening to the outside via the vent.

Costal grooves—vertical grooves on the sides of the salamander's body.

Cutaneous—pertaining to the skin.

Dorsolateral fold—a glandular ridge of skin along the junction between the back and the side in certain ranid frogs.

Fossorial—having burrowing habits and living underground.

Gular fold—fold of skin running across the throat in salamanders.

Hypothalmus—part of the pituitary gland at the base of the brain.

Intercalary cartilage or bone—extra element between the last two bones of the digits of hylid frogs (treefrogs).

Labial teeth—horny teeth arranged in transverse rows on the lips of tadpoles.

Larva—an immature form of an animal that radically differs in appearance from the adult.

Metamorphosis—the change that a larva undergoes as it transforms into an adult.

Nasolabial groove—a fine groove running down from the nostril to upper lip in lungless salamanders.

Neoteny—the condition whereby a larva fails to metamorphose into adult form, resulting in a permanent, sexually mature larva.

Parasphenoid teeth—teeth associated with the parasphenoid bone on the roof of the mouth and characteristic of plethodontid salamanders.

Parotoid gland—a large, raised, skin gland located at the back of the head behind the eye in toads and certain salamanders.

Sacral—pertaining to part of the pelvis. In frogs, the sacral hump is formed where the pelvis meets the backbone.

Spade—a large, horny tubercle on the sole of the foot in burrowing toads.

Spermatophore—small jelly packet containing sperm laid by male salamanders in mating.

Spermatheca—internal sac in female salamanders used to store sperm.

Suctorial—acting like a suction cup.

Tubercle—a raised bump on the skin, not a poison gland like a wart.

Vocal sac—inflatable sac under or at the side of the throat in male frogs and toads that acts as a sound resonating chamber.

Wart—raised poison-containing gland on the skin of a toad or other amphibian.

USEFUL REFERENCES

For a complete listing of literature pertaining to amphibians in British Columbia, please refer to:

Campbell, R. Wayne, Michael G. Shepard, Brigitta M. Van Der Raay and Patrick T. Gregory. 1982. A Bibliography of Pacific Northwest Herpetology. British Columbia Provincial Museum Heritage Record No. 14, Victoria. 151 pages.

The following is a list of references that may be interesting for further reading:

General Works

Cockran, D. M. 1961. Living Amphibians of the World. Doubleday, Garden City. (A superbly illustrated and readable account of amphibians and their ways of life.)

Goin, C. J., O. B. Goin and G. R. Zug. 1978. Introduction to Herpetology. Freeman, San Francisco. (A useful introductory textbook.)

Leviton, A. E. 1970. Reptiles and Amphibians of North America. Doubleday, New York. (A readable, general account of the North American herptofauna with excellent photographic illustrations.)

Noble, G. K. 1931. The Biology of the Amphibia. Dover, New York. (This is a classic that is still frequently referred to although some parts of it are out of date.)

Porter, K. R. 1973. Herpetology. Saunders, Toronto. (A comprehensive survey of the biology of amphibians and reptiles.)

Vial, J. L. (ed.) 1973. Evolutionary Biology of the Anurans. University of Missouri Press, Columbia. (A symposium of scientific papers presenting many aspects of current major interest in the study of frogs and toads.)

Field Guides and Handbooks

Behler, J. L. and F. W. King. 1979. The Audubon Society Field Guide to North American Reptiles and Amphibians. Knopf, New York.

Bishop, S. C. 1943. Handbook of Salamanders. Comstock, Ithaca, New York.

Cook, F. R. 1984. Introduction to Canadian Amphibians and Reptiles. National Museum of Natural Sciences, Ottawa.

Froom, B. 1982. Amphibians of Canada. McClelland and Stewart, Toronto.

Hodge, R. P. 1976. Amphibians and Reptiles in Alaska, the Yukon and Northwest Territories. Alaska Northwest, Anchorage. (A well-presented and well-illustrated little book of northern herpetology. Many of the species discussed are also found in British Columbia.)

Nussbaum, R. A., E. D. Brodie and R. M. Storm. 1983. Amphibians and Reptiles of the Pacific Northwest. University Press of Idaho, Moscow. (Up to date and comprehensive).

Smith, H. M. 1978. Amphibians of North America. Golden Press, New York.

Stebbins, R. C. 1966. A Field Guide to Western Reptiles and Amphibians. Houghton-Mifflin, Boston. (This is still the best field guide available for identifying amphibians and reptiles in western North America. A new edition will soon appear.)

Wright, A. H. and A. A. Wright. 1949. Handbook of Frogs and Toads. Comstock, Ithaca, New York. (Although some of the classification is out of date, this and Bishop have excellent accounts of North American amphibians and are filled with interesting observations and anecdotes.)

Scientific Journals and Societies

Three scientific societies in North America publish journals dealing with the biology of amphibians. Membership in any of these societies is not expensive. They are:

American Society of Ichthyologists and Herpetologists, publishers of the journal *Copeia*.

The Herpetologists' League, publishers of *Herpetologica*.

Society for the Study of Amphibians and Reptiles, publishers of the *Journal of Herpetology* and *Herpetological Review*. The *Canadian Field-Naturalist*, published by the Ottawa Field-Naturalist's Club, and the *Canadian Journal of Zoology*, also frequently contain articles on herpetology.

These journals may be found in university libraries and contain information on how to join their issuing societies.